*To my wife.*

Of the making of books there is no end.
There would have been no ending
to this book
except for Helen's help.

# Foreword

MAN HAS, NATURALLY, ALWAYS BEEN INTERESTED IN THE MAKings and workings of his body. My own interest in the body has been specialized, perhaps partly because of heredity. I spent my early years in the house of my grandfather, a surgeon on Cape Cod in the "one-hoss-shay" days of Oliver Wendell Holmes. Fortunately, even in those days, the railroad made it easy for him to mingle with the learned men of Boston: anatomists, physiologists, physicians, and surgeons. At least I was started right. Later, in the biology department of Brown University, I became acquainted with the appearance of body tissues and at Harvard Medical School with the activities of those tissues.

But had my friends and I stopped there, how meager would have been our knowledge. Physical science has advanced since then at a speed never dreamed of before. Now the danger is not that we will not know enough, but that we will fondly believe that we understand all the knowledge we but dimly perceive.

If you study Gray's or Cunningham's *Anatomy*, books devoted to the description of parts of the body big enough for you to see, you will be appalled at the multiplicity of descriptions. Then you may turn to Best and Taylor's *Physiology*,

which recounts a reaction in the realms of chemistry or physics for every muscle, nerve, bone, blood vessel, or what have you, mentioned in Gray. A nice old lady, very kind to me, but somewhat on the pompous side, her husband being a federal judge, remarked, when I told her I was to study medicine: "After all, there are only three hundred and sixty five bones in the body. Think of the complexities of the law." I didn't argue with her, for, to tell the truth, I have never counted the bones. The law, being man made, I am sure is complex beyond the mind of man.

What between astronomy and federal expenditures, we are accustomed to talk in large figures, far beyond what our minds can really comprehend. As light is said to travel 186,000 miles a second, it is instantaneous for all worldly purposes. Then the astronomers tell us of millions of light years. Having vaguely prepared our minds to admit the existence of such vast things, we may consider a cell of the body, seen only through a microscope. The very antithesis of vastness, things infinitely small, presumably, exist in the cell. Apparently a single cell may have enzymes galore, producing chemical changes; and the chromosomes possess all the characteristics of a particular individual. Could we comprehend all this and consider the billions of cells in a human body, and at the same time work out the problems of combinations and permutations for such numbers, our wonderful body would then be an open book to us.

Already, in the last half century, we have read and partly comprehended many a new page. Our study of the hormones, most promising but at the present time accentuating some of our blind spots, has taught us that small masses of tissue nestled at the base of the brain, below the stomach, and at other strange places, may influence the inner workings of every cell in the body. ACTH and cortisone are leading us to a realization that mental processes affect the adrenals perched on top of the kidneys, and so on to the whole body. How this almost infinite number of cells work together to give us, we hope, a full and happy life, is a marvelous example of interplay and coordination.

Ralph Waldo Emerson might well have been speaking of the human body when he said:

All are needed by each one;
Nothing is fair or good alone.

It is no easy task to separate the inseparable or to try to describe the human body as a series of different systems — digestive, respiratory, circulatory, etc. Everyone today has heard of Vitamin B; it is naturally in your food, if you eat a well-balanced diet, and is also available for a price at the drugstore. Lack of a part of the Vitamin B complex affects the nervous system. You have been told, if you do not know it from personal experience, that your food does not digest so well when you are tired or worried. How is one to describe the effect of the food on the nerves or of the nerves on the food? When and where should "blood sugar" be discussed? The amount of sugar in the blood is affected by what you eat, by the action of a certain "internal secretion" gland, by the effect of emotions like anger on the glands. It is easy to see that the interplay of the "different" systems in the body makes any outline description difficult.

Of course, in the last analysis, despite much scientific research and progress, what really makes animal tissue come alive is beyond human ken. The infinite number of activities going on in our cells during life ceases with death. The life process is not entirely explained by the laws of physics and chemistry. But then, an essential part of wisdom is to realize what one does not know.

You will notice at the start of Chapter I, that I will solve one of the world's great problems: "Which came first, the hen or the egg?" It was the egg. The hen followed some billions of years later. A long series of eminent biologists led me to this conclusion. One friend stands at the culmination of all this knowledge: Dr. J. Walter Wilson, head of the department of biology at Brown University, who has, with the willing cooperation of many of his staff, given me great help. The late Professor Herbert J. Walter, of this department, wrote *The Biology of the Vertebrates,* as delightful to read as it is informative; a copy of this book was always at my elbow. The development of man's higher faculties has made it possible

for him to rise above the other animals, but it would be a great mistake, in observing his body and its functions, to ignore the study of comparative anatomy.

Undoubtedly my chief help in compiling this book, aside from a lifetime of practice with its attendant reading of medical literature, has come from my innumerable quizzes of the more able members of the profession, with whom I have been on intimate terms. Their patience with me has been inexhaustible. I have divided these learned men into three classes, irrespective of their specialties: the loquacious, who have poured their special brand of mental nutriment into me faster and richer than I could easily assimiliate it; the inarticulate, who also have much knowledge and are excellent practitioners, but who are awkward in dispensing their lore; and the ideal coming in-between, who give me quickly and accurately their help. One and all, their kindness has made me fond of my profession. The librarians, led by Mrs. David Cornel De Jong, of the Rhode Island Medical Library, have been enthusiastic collaborators with my medical friends and myself.

What has most directly led up to this storehouse of information, anatomical, physiological, psychological, and medical, is the series of articles, alternating with questions and answers, which I have contributed to the *Providence Journal and Bulletin*, four a week, for over nine years. These have by no means been intended to take the place of the family doctor. In fact, my frank friends have, in what I hope is an admiring manner, remarked on the diversity of ways in which I have managed to say, "See your doctor."

While writing my column, "Your Health," I have had much experience in trying to explain to the layman, clearly and concisely, the workings of his body. Without this practice, I would never have had the temerity to attempt this book. Much of it, naturally, tells of parts and functions of the human body that I have described in my column.

I wish to express my thanks to the editors of the *Providence Journal and Bulletin* for their encouragement of me as a columnist, for the latitude which they have always given me, and for their permission to use some of the material that has appeared on pages of their papers.

Frequently I have been advised that popular articles must be written for the fourteen-year-olds. This has not been altogether pleasing, so I have often resorted to a sort of double-talk. The accurate language of science is still largely in the classical tongues, Greek and Latin, which I have used somewhat and then attempted to translate into the less forbidding but unfortunately less accurate Anglo-Saxon. In this way it seemed possible to cater to those with little scientific background and yet be ready for the critical view of professional friends who flatter me by reading my lucubrations. Talking with run-of-the-mill patients and cultivating an acquaintance with the faculty of nearby Brown University has, I hope, given me a wide spread. Among these latter, the one who has taken the most time and trouble, although others have contributed liberally, is Professor Benjamin C. Clough, of Brown University.

A teasing remark about the medical profession is that:

> Internists know everything and do nothing.
> Surgeons know nothing and do everything.
> Obstetricians know nothing and do nothing.

Dr. Alex M. Burgess, my classmate in college and medical school and a near neighbor of mine ever since, qualifies for the first three words of the above aphorism. He has been for me a great and ever-willing help, the very symbol of a co-operative profession. Besides writing the verses on the heart beat (quoted on page 132), he gave me in his recent talk to our class reunion many wise and happy thoughts on growing old which with his permission I have incorporated into the section entitled "Growing Old." I have consulted him often on other parts of the book. Among other medical friends who have advised me about special parts of my manuscript, I wish to mention, gratefully, Dr. Stanley S. Freedman, Dr. Robert V. Lewis, Dr. Wilfred Pickles, Dr. Charles Potter, and Dr. John G. Walsh.

Mrs. Donald T. Lamon has not only done excellent secretarial work on the manuscript but has also been of great help to me by her worldly-wise advice on the public's reaction and liking.

The numerous illustrations and diagrams have been gathered together from many sources. The diagrams have for the most

part been copied or adapted from ones already published. The illustrations come both from old masters and more modern pictures already published. The Historical Library at the Yale Medical School has been particularly helpful in locating these. For permission to use these illustrations and diagrams, grateful acknowledgment is hereby made.

If I began to name all the kind friends to whom I owe thanks, the list would be great:

The things are few
They would not do
In friendship's name.

The modern world exalts education. Before the medical student gets even a peek at medical matters, he is forced to accumulate the fundamental knowledge which this book attempts to condense and interpret for the layman. It is to be hoped that this latter personage will still realize that he is absolutely unqualified to repair and regulate the human body, most mysteriously complicated as it is. Instead of the familiarity which breeds contempt I trust that the layman will get the realization that his body is fearfully and wonderfully made and must be treated with the greatest respect.

# Table of Contents

Your
Wonderful
Body

# 1. Man in the Making

## ORIGIN AND DEVELOPMENT

Scientists are agreed that animal life began in the simplest of forms and slowly through the ages changed and increased in complexity. Single-cell animals increased in number by merely dividing, each in two, every resulting cell having all the attributes that the parent cell had. In the biological laboratory one can see the amoeba doing this.

As more elaborate animals evolved, consisting of many cells, certain cells began to take on special functions, and gradually organs evolved to perform these functions more efficiently. Of course the most important function of all was reproduction, without which the race would cease to exist. Ultimately the two sexes were established and this duality is to be found in all but the very lowest forms of life. At a slightly advanced stage both male and female forms may be found in one individual, but development never continues far in this line. Individuals in all higher stages are distinctively either male or female.

The history of the development of a race is called phylogeny; that of an individual, ontogeny. These are big Greek words but their meaning is simple enough. When we use the mouth-filling phrase, "Ontogeny is the recapitulation of phylogeny," and apply it to humans, we are simply saying that any individual, as he or she grows in the womb, goes through the stages that the ancestors from the beginning of life in the world have passed through.

## *The growth of the embryo*

Each human being starts as a single cell from the mother's ovary, which is a specialized sort of cell that contains a germ with reproductive and hereditary substances, called an egg or ovum. The ovum cannot develop unless it is fertilized by a sperm from the father. Here we are on a par with the beasts of the field or the fishes of the sea. Those of you who have read Isaac Walton's *The Compleat Angler* will remember that he quoted the following about strawberries: "Doubtless God could have made a better berry, but doubtless God never did." So doubtless He could have devised a better scheme than that of the two sexes to perpetuate the race, but He did not.

However, we proudly maintain that humans are different from the others—somewhat. Although the ovum, or egg, of the human female is in the beginning much the same as that of the other higher animals, the sexual activities that are concerned with the fertilization are highly characteristic with mankind. Mammals in general have a period, often only once a year, when the female will receive the male. This is called estrus, or "heat." Human females, as is well known, will receive the male at almost any time. However, the period when they may become pregnant occurs once a month, in between the times of menstrual flow.

You all know that the human female goes through a cycle every lunar month, that is, four weeks. The visual evidence of this, menstrual flow, is, it would seem evident, associated with the attempt to prepare the uterus for pregnancy. Somewhere between two menstrual flows an ovum is freed from the ovary. Left to itself it passes down through the uterus and is lost

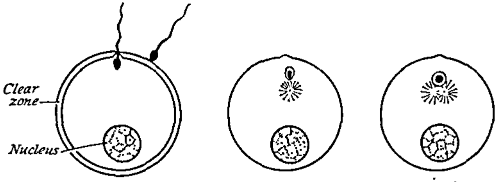
forever. Then the blood vessels which, in anticipation of pregnancy, have been forming along the inner surface of the uterus, break down, the familiar flow of blood occurs, and the uterus returns to its original condition.

Although as a usual thing only one ovum is freed at any one period, the male sperms are present in millions after intercourse. Each of these is shaped like a tadpole and moves in a similar manner. It travels through the cavity of the uterus and along inside one of the Fallopian tubes whose open end is near the ovary. If one of these sperms joins with an ovum, it penetrates through the surface and pregnancy has occurred.

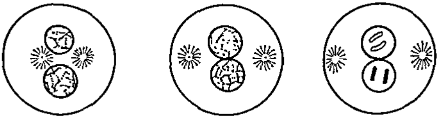
Although the ovum and the sperm meet and unite in the tube, the resultant embryo usually travels along to its proper place in the uterus. Unfortunately this does not always occur. Sometimes it stops in the tube and begins to grow there. The tube cannot respond as the uterus does and sooner or later it ruptures. This causes severe pain and bleeding and a serious surgical emergency results. Occasionally the fetus remains in the abdominal cavity.

When, as usual, the fertilized ovum reaches the uterus, it attaches itself to the wall prepared for it by the changes which have been leading up to menstruation. Until recent years most knowledge of these matters was obtained from the study of animals with the reasonable supposition that in important respects some of the higher animals develop much as humans do. Some ten years or more ago Drs. John Rock and Arthur T. Hertig, of the Free Hospital for Women in Brookline, Mass., found an embryo in a woman's uterus removed at operation. It is believed to be about seven and a half days old and is so small that it can barely be seen with the unaided eye. At this stage it was already partly buried in the uterine wall.

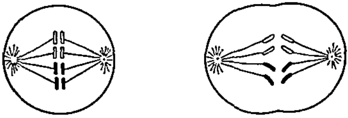
Soon after the cell and sperm have united, the cell divides into two. The process of dividing continues, each time doubling the number, and by the time that Drs. Rock and Hertig found their specimen, there was quite a mass of cells. At first there is a single layer of cells. This soon begins to infold, forming two layers, and then there is another infolding of the inner layer. Long chapters of books on embryology are devoted to describing the details of this process. It is sufficient for you to know



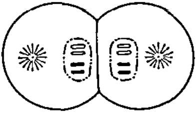

a. Entry of sperm into ovum. b. Loss of sperm tail. c. Division of sperm.



d. Approach of sperm nucleus. e. Increase of sperm nucleus. f. Formation of chromosomes.



g-h. Splitting of chromosomes, which contain inherited characteristics.

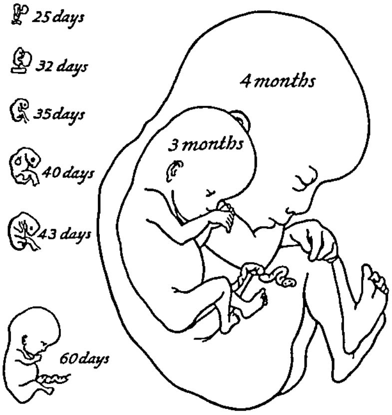


i. Two-celled stage.

Fertilization. (*Walter & Sayles,* Biology of the Vertebrates, 3rd Ed., *p. 137. New York: Macmillan 1949. Reprinted by permission.*)

that these three layers are called ectoderm, endoderm, and mesoderm — outer, inner, and middle layers. Infolding and twisting continue and soon definite shapes are evident.

From the ectoderm are formed the skin, hair, nails, the lining of the mouth and rectum, the nervous system and sense organs, such as the eyes and ears, or parts of them at any rate. The

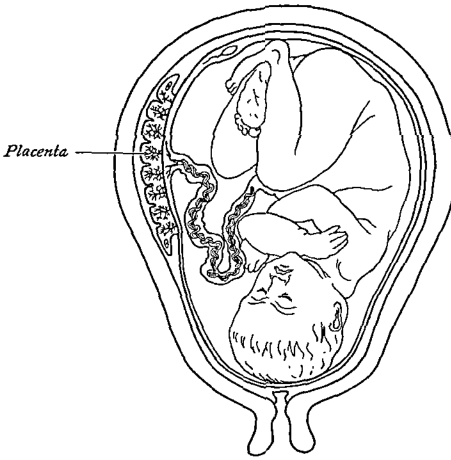



Human embryos of 25 days to 60 days (His) and fetuses of 3 and 4 months. (*After L. B. Arey, Developmental Anatomy p. 134. W. B. Saunders Co., 1938.*)

endoderm gives us the lining of the digestive tract, the liver and pancreas, the lungs, and some more. The mesoderm furnishes a great variety. It is enough to mention the bones and muscles and connective tissue, the circulatory system, and the organs of reproduction. In the fully developed body certain parts may have been formed from two or more of these layers.

But before the body has developed to any recognizable shape the outer layer of cells has been forming branches which

push into the wall of the uterus like the roots of a tree. Thus the placenta, or afterbirth, is formed and from now on the tremendous demands of the embryo for nourishment are supplied by a sort of filtering, as it were, of materials from the mother's blood to that of the child through these roots. The



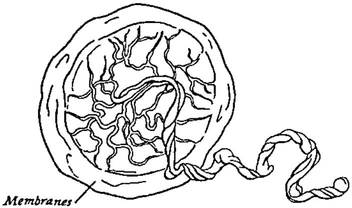

Longitudinal section of the uterus, showing the relation of advanced fetus to the placenta. (*After L. B. Arey,* Developmental Anatomy, *p. 137. W. B. Saunders Co., 1946.*)

blood cells themselves are too large to cross this barrier as are other substances in the mother's blood which are said to have too large molecules.

The embryo grows at an enormous rate. During its life in the womb it may increase its weight two billion times. Hence it is not remarkable that its need for nourishment cannot be

met by fluid diffusing about the cells and that the heart and blood vessels begin to form about the third week.

The growth of the placenta keeps pace with this and from it membranes soon form. They fill with fluid which compresses the attachment between the child and the placenta until it becomes a narrow cord. The result is that we find the child suspended in the fluid retained by the membranes while it is connected to the mother only by the umbilical cord from its navel. It remains protected in this way until the time of its delivery.




Placenta after expulsion. (*L. B. Arey*, Developmental Anatomy, *p. 139 W. B. Saunders Co., 1946.*)

Placenta is the Latin word for a flat cake and that accurately describes its shape after it has been delivered from the uterus. It is usually a good inch and a half thick at the middle, thinner at the edges. Its diameter is six or eight inches. It may be at any position on the wall of the uterus according to where the ovum happened to attach itself but fortunately this is usually near the top. If the ovum goes well to the bottom before taking hold, an unfortunate condition then occurs known as a placenta previa. This leads to a bad complication of pregnancy, for the placenta is over the external opening of the womb. When labor begins, this opening, called the os uteri, enlarges, pulling away from the placenta, which causes tearing of the blood vessels and bad bleeding. In normal labor after the baby has been delivered the uterus continues to contract, separating the

placenta which quickly follows after the baby. Hence the very logical popular name, afterbirth. Then contraction of the uterus closes the vessels in the raw area left on its wall, and stops the bleeding.

## *The controversy Darwin started*

Up to the point to which the story has been so far told, with the placenta beginning to develop and the cells of the embryo multiplying and forming into layers, there has been little to distinguish the growth of a human being from that of other animals. Superficially the cells seem all alike, but minute as they are, their internal structure has a good deal of complication. The material of which the cell is composed is called protoplasm, and embryologists have a rather elaborate description of its arrangement. All that it is necessary to tell you about is a part of it called chromatin. This forms in a ribbon-like shape and breaks up into small pieces called chromosomes. The number of these chromosomes varies with different kinds of animals. Man has a lot.

The chromosomes are the containers of all the characteristics which the individual has inherited. When the sperm unites with the ovum, there ensues a mingling (if that is the correct word) of the chromosomes of both parents. Hence the resulting child inherits characteristics from both sides of the family tree, although usually it cannot be predicted which will predominate.

From now on the mysterious influences contained in the little strips of chromatin cause the embryo to rehearse in a few short months the infinite changes which have taken place in the eons since its ancestors were minute specks of matter floating about in the slightly salty Cambrian Sea. Until comparatively modern times it would have been ridiculous to hint to the general public this story of how the development of the race is epitomized in what goes on in a woman's womb during pregnancy. But Charles Darwin, a century ago, published *The Origin of Species* and precipitated great discussions of these biological problems.

Naturally the details are most vaguely grasped except by

specially trained scientists, but few of you have failed to learn that the human body starts as a single egg; is then a formless collection of cells; later has gills suggesting that like a fish it is intended for swimming; becomes something like a reptile; soon cannot be easily distinguished from any small quadruped; then grows hair and suggests an ape, and is finally born as a baby which we are proud to admit is a human, although it is still a far cry from a well-developed man or woman. In fact one fond mother admitted that her curled-up infant suggested a cut-worm.

There are still people who are outraged by all this and protest that they are not "descended from a monkey." Others of us who, on a spring morning, see a small shoot of green, indistinguishable from a weed, and a few days later find it transformed into a gorgeous tulip, feel that to be truly miraculous. With the same spirit we are awed by the thought that man, starting from the lowest beginning, may soon arise to something slightly lower than an angel.

It is interesting to know that a little tail appears at one period of gestation but it does not amount to much. We are proud to assert that there is no good evidence that we had a monkey in our family line. The embryo is for a time covered with hair; probably this is what led to the statement that man is descended from an ape. But then an ape is more respectable than a monkey.

Occasionally some of these primitive conditions persist after birth. I have never seen a tail on a human but I have seen many remains of what correspond to gills in a neck. Only last year a young girl was brought to me with a minute opening in the side of her neck where occasionally a drop of moisture would appear. When we operated we found a thin walled tube running among blood vessels and other structures to the tonsil, where we cut it off and removed it. This was a remnant of one of the gill clefts. Much more common is a similar condition, which starts at the skin by the thyroid gland in the front of the neck and runs right to the base of the tongue. This is still another gill cleft. We are warned, however, not to draw the conclusion that somewhere in the past our ancestors were fishes, somewhat similar to what we now see. We may only presume

that there was some relationship between our grandparents many billions of generations back and the fish's progenitors of the same period.

Striking changes in the embryo occur early and rapidly. I have before me a picture of one eight weeks old. The youngster already has arms, legs, eyes and ears. But what impresses one most is the great bulging forehead reminding one of the erudite Boston boy of the cartoons and apparently at this stage giving a portent that he is to become *homo sapiens,* the wise man.

Embryo, eighth week. 1.8 normal size. (*After G. W. Corner,* Ourselves Unborn, *p. 65. Yale University Press, 1944.*)

The story of the development of the multitudinous parts of the body is of necessity complicated and fills large books. Remembering that it was said earlier that the embryo in developing follows the pattern of the development of the race, it is not remarkable that some parts form early and later cease to exist. Examples are the tail and gill clefts in the neck.

Other parts continue to exist but in a degenerated form. In some animals the appendix is large and apparently useful. It seems to be a continuation of the part of the large intestine to which it is attached. I have seen no good argument that it is of value in the human body and it certainly is often a great nuisance. Perhaps at some future period it will cease to develop.

Another vestige sometimes remaining, although it is uncommon, is a Meckel's diverticulum. The German anatomist, Meckel, was the first to describe a pouch occasionally found leading from the small intestine about a foot from the appendix. The intestine twists about so that the two organs may be almost touching each other. The diverticulum is the remains of a yolk sac. Now a yolk sac is important to a developing chick, as it contains the material from which the the chick is built. Although we get our nourishment from mothers' blood through the placenta, nevertheless we have a yolk sac in early life. So do

apes, bats, and armadillos. It looks as though we could not duck our connection with these poor relations. Fortunately this yolk sac which joins with the intestine usually withers up and disappears long before we are born.

## *Accidents sometimes happen*

During the third week of the life of the embryo, the heart starts to develop. It is at first only an enlargement of blood vessels which soon begins to beat and move the blood along throughout the whole body. The heart gradually changes into the shape that it holds after birth even though no blood goes from it to the lungs until the child is born and begins to breathe.

Meanwhile the blood completes its circuit for, from the vessel which normally should take it to the lungs, a broad short tube called the ductus arteriosus side-tracks it back to the main great artery, the aorta. When the child is delivered, with its first cry or gasp the lungs fill with air. After this the ductus normally closes off. Occasionally it does not; then some of the blood, which should go to the lungs to receive its oxygen, sticks to its old route by what we now call the patent (that is, open) ductus arteriosus. You can see that it is a handicap to the child to have a considerable portion of its blood unfreshened by oxygen.

Such persons are weak and physically inefficient. Sooner or later infection of the lining of this blood vessel sets in and death is likely to occur by the thirties at the latest. One of the most brilliant developments of recent surgery is the surgical closing off of the ductus, devised by Dr. Robert Gross, of Boston. When this is done, the blood then has to follow its normal course.

For many reasons development does not always go smoothly and according to schedule. It is thought that pregnancy not infrequently occurs and is then interrupted at such an early stage that it is not even suspected. Biologists with carefully conducted experiments on animals can injure embryos and cause them to develop in abnormal forms. From this it is reasoned that accidents to human embryos may cause abnormal forms.

It is usual for a human female to give off one ovum at a time. Occasionally at an early stage something causes the embryo to divide into two individuals, each of which develops normally. Then we have like, or identical, twins. They are always of the same sex and look alike. This is very different from the case where the mother gives off two ova at a time. These twins are not necessarily at all alike.

Unfortunately, whatever happens to the early embryo may occasionally result not in complete division and twins, but in partial division which may give such abnormalities as Siamese twins. In the past such occurrences seemed to be controlled by chance alone. Apparently there was no rhyme or reason in the whole matter. In recent years we are beginning to get some evidence of cause and effect.

Possibly the first definite light on this came from Australia. About a dozen years ago a physician there studied a series of cases of congenital cataract which occurred in a period of about a year. A cataract is a change in the lens of the eye which obstructs the rays of light. This occurred to the babies at birth or soon after. A short while previously there had been an epidemic of rubella, or German measles. Investigation showed that some expectant mothers who contracted rubella during the first three months of pregnancy later had babies with congenital abnormal changes, usually cataracts.

This discovery started a series of investigations on animals. It has been found that there are numerous ways by which the embryo can be injured with resulting deformity. The stage of uterine life at which the injury occurs seems to determine the type of congenital defect.

The above tale may seem at first rather depressing, but further consideration will show a decidedly hopeful aspect. When we are in the dark as to the cause of trouble we know not what to do to avoid it. Once the cause is determined we may proceed to campaign hopefully against it. Medical history is full of evidence to this effect. In my youth "typhoid lit its dusky flame" every fall. But by that time we had learned the cause, and although we had no drug to combat it, the added knowledge as to its manner of spread and our ability to recognize it early soon enabled us to get almost complete control over it.

Today it is hard to find a case for medical students to observe. Our knowledge of vitamins has made it possible to avoid rickets, scurvy, pernicious anemia, and other deficiency diseases.

So it should be a cheering thought that the defective development of a child in the womb is not controlled by mere chance. There is always a definite cause. Our knowledge of these causes is increasing rapidly, and already we have some control over them. Better medicine, better obstetrics, and the education of prospective parents are making childbirth an even more happy prospect.

## *The bright outlook on childbirth*

I have been talking of the little gloom that still lingers in the usually bright and shining outlook on childbirth. There really is not much, but many an unfortunate mother has had her attention called to the threatening clouds. Rarely has she read the reports of lying-in hospitals or the statistics of life insurance companies.

These are about the most cheerful medical writings that I know of. They are testimony to nature's great desire to perpetuate the race. Once one of the millions of spermatozoa has united with an ovum, pregnancy has begun; and by the time the woman becomes aware of her condition, the odds are overwhelming that she will go safely through labor and possess a healthy child.

The blood of the mother and that of the child do not actually mix, but the blood vessels of the two are separated from each other by the very thinnest of membranes. Only substances that can be carried in solution in the mother's blood and pass through these membranes can get into the child. Such membranes are present in all living things. They are called semipermeable. In the lungs, for instance, the air that is breathed in is almost but not quite in direct contact with the blood. Through such membranes the oxygen goes from the air into the blood and carbonic acid gas (that is, carbon dioxide) travels in the opposite direction. The blood and its other ingredients do not pass.

Professor G. W. Corner, who has written a delightful book

called *Ourselves Unborn,* says that he demonstrated the characteristic operation of such a membrane by putting indelible ink into a sausage skin and suspending it in water. The grains of carbon in the ink, too fine to be seen under a microscope, would not color the water as they could not get through the membrane. Then salt was mixed with the ink and in a little while it could be tasted in the surrounding water. This proved clearly that there is a selectivity in these membranes. Those of the placenta can, as it were, choose or change the substances which should pass through.

## *Pre-natal impressions*

Except for such phenomena as the above the infant is completely separated from the mother. There are no nerve connections between them. The mother does not feel it when the umbilical cord, the one connection between the pair, is cut. There are no means for transmitting memories or ideas.

Yet throughout the ages people have believed in "pre-natal impressions." This is the belief that if a woman while pregnant is seriously alarmed or injured, the experience may leave a mark upon her child. How often when children have been born with spastic paralysis, having little control of their muscles and possibly with weakened minds, it has been said that the mother was, while pregnant, molested by a drunken man. Even Dr. Oliver Wendell Holmes, in his novel *Elsie Venner,* discussed the serpent-like nature of a young woman whose mother had been bitten by a rattle snake when she was bearing her child. Yet one cannot help feeling that even a century ago that practical anatomist and well-trained medical man expected his story to be taken only as an interesting fantasy.

The Bible quotes at least one such (supposed) case of the influence of maternal impressions. Burton in his *Anatomy of Melancholy* three centuries ago cited numerous examples; and even in my time a distinguished college president quoted such cases to his class. You will notice that sensations of grief, terror, and other unpleasantness are what pass through to injure the child. No one competent observer suggests that any lovely, intelligent, sweet-dispositioned child possesses these charac-

teristics because the mother spent her period of pregnancy visiting art galleries, attending symphony concerts, and reading the world's best literature.

Embryologists (those are the persons who devote themselves to studying what has been discussed here) are more than sceptical about pre-natal impressions. They do not believe in them at all. If you were told that a hen, having laid a clutch of eggs, was scared by a hawk before the eggs hatched and the chickens turned out to be Barred Plymouth Rocks with cross markings on their feathers like those of a hawk, you would pooh-pooh the idea of cause and effect. But when we come down to fundamentals the hen and the human mother are producing a chick or a child by the same process. The hen puts an ovum no bigger than the point of a pin, together with a lot of nourishment, inside a hard shell for protection. The egg is kept warm until the ovum has absorbed all the nourishment and grown into a chick. The human mother puts her ovum in her warm womb and then stands by to furnish the nourishment through the cord and placenta until the child has grown to man's form. The idea is the same. Only the technique is different.

## A CHILD IS BORN

During the nine calendar months which equal ten lunar months, or two hundred and eighty days, innumerable changes take place in the embryo, very few of which we can observe from the outside. The increase in size is, within a few months, noticeable by the change of the mother's figure, although the amount of fluid within the membranes may have much to do with this appearance. The heart has taken shape by four weeks and begins to beat, but it is months later before it can be heard. What is remarkable is the early age at which muscular movements start. An obstetrician of great experience tells me that he has felt them at sixteen weeks and it is not unusual to get them before he hears the heart beat of the child. May not this mean that nature has not as yet caught up with the gadget age and is still working on the assumption that man will continue to make an active use of his muscles?

The head, which is very large at eight weeks, continues until

some time after birth to be bigger in diameter than the body. Do not take this as evidence of man's great brain function. The only use of a head until long after birth is as an efficient dilator of the birth canal. One other organ which is active during life in the womb is the skin. You know that your own skin is always excreting grease. I think that it is even more active before birth, when the baby is covered with a thick, greasy, cheesy material called the vernix caseosa, which is Latin for "cheesy varnish." When you consider what a few minutes of daily dish washing may do to the skin of hands, you will realize what might happen to the skin of a baby soaking for nine months without this protection.

## *The three stages of labor*

What starts labor at the end of nine months? I will lay my cards on the table and tell you I do not know. I do know that it is not the castor oil and quinine which so many unfortunate young women have taken. If they are ready to go into labor, this nauseous mixture will be followed by labor pains. If not, they will have only diarrhea and ringing in the ears. The common opinion (evidently shared also by obstetricians) has been that if one irritated the uterus, labor contractions would begin. It is not at all certain that quinine irritates the uterus any more than the rest of the body. Castor oil irritates the intestines because it is partly digested there and in this process the bland material breaks down into substances which cause tremendous bowel disturbances. They do not get into the uterus, however. I think the world would be just as well off if no more castor beans were grown.

A pregnant uterus may be very long suffering without being dissuaded from its original purpose to baby sit for the proper length of time. I once removed an acute appendix from a woman who was expecting to go promptly into labor. In fact she was in a lying-in hospital. Her uterus was bigger than a modern football, the appendix was behind it, and we of necessity had to be very rough with the uterus. Did all of this irritation start her promptly into labor? It did not. In fact it was two weeks before she had a normal labor.

At any rate, when the time comes, the muscular uterus begins a series of rhythmic contractions. What first happens reminds me of your morning experience with your tube of tooth paste. When you squeeze on it, there is only one place where the contents can come out. So with the uterus. There is an opening at the bottom. The baby is in a sac full of fluid. Each contraction squeezes this sac down into this opening which gradually gives way and dilates or opens. In the normal course of events when it is entirely open, the sac breaks, letting out the fluid and the baby's head is forced downward. Midwives say that the "waters have broke." If the waters break early, it is called a dry labor, for the head is not so efficient a dilator, This is the first stage of labor.

In the second stage the head gradually pushes out, and after it is out the smaller body comes easily. The third stage is getting the afterbirth out. Once in a while the membranes which form the sac do not break and the baby is born with this veil of membranes covering, but not attached to, his head and face. The veil is called a caul and is supposed to bring good luck to the child. Usually it is thrown away with the afterbirth to which it is firmly attached, but sometimes it is wrapped up and kept. John of Gaunt is one of the famous characters in history who carried his on his person, like a charm, and believed that it brought him good fortune.

## *"Natural childbirth"*

Labor is a normal physiological process. Throughout time immemorial the overwhelming proportion of cases have delivered without help. This is the basis for the modern "natural childbirth." It is founded, of course, on Rousseau's hypothesis that the savage in a state of nature is the perfect man, but man (and woman) has assumed the upright posture and the changes incident to this have not facilitated childbirth. Numerous observers amongst savage tribes have testified that savage women have possibly as much difficulty as the civilized women. The biblical statement still holds with some women: "In sorrow shalt thou bring forth children. . . ." But these are exceptions. On the Lewis and Clark expedition, an Indian and his squaw

(Metropolitan Museum of Art)

*The Birth of a Baby.* This seventeenth century engraving, by Abraham Bosse, shows the common practice before the time of modern obstetrics. No fewer than five midwives — and no doctor — are assisting.

dropped out from the line of march. A day later, they had joined again with a newborn baby. At the turn of this century, my mother's washerwoman had a baby while no one else was in the house, took entire care of it, and was doing a washing the next day. Now that lying-in hospitals are getting crowded, obstetricians have found that new mothers can go home almost as promptly as this.

### *Progress in obstetrics*

Until recent times midwives have had entire charge of women in labor, and there have been advantages as well as disadvantages in this custom. In the past much meddlesome obstetrics has been done, but, on the whole, modern obstetrics has been increasingly triumphant. The first great advance was the invention of the obstetrical forceps by the Chamberlen family nearly three hundred years ago. This family, contrary to the ethics which good medical men like to practice, kept the secret for several generations. Forceps are used when the mother cannot expel the baby by her own exertions. There are various reasons for this use: the baby may be too large in relation to the mother's dimensions; the mother, because of prolonged labor or other reasons, may be too exhausted to furnish the proper propulsive force; the baby may be lying in the wrong position. Modern forceps consist of two pieces of metal curved so as to fit both the baby's and the mother's anatomy. They lock firmly after they have been placed in position. A handle allows the obstetrician to manipulate the forceps and pull the baby down at the speed and in the direction that he wishes.

When the forceps became generally used, they were, of course, abused. The "high forceps" of a generation ago was brutal. In such an operation, the forceps were applied to the child's head while is was still far up in the pelvis and had not been moulded by the force of labor into a shape which would allow it to come down easily. The pulling of this great head usually resulted in much damage to the mother's tissues. Our ability to remove the baby by operation (the so-called Caesarean section) in a simpler, safer manner has outmoded this danger.

The good modern obstetrician exercises, in the words of one of my former teachers, "scientific apprehensive expectancy." He should let most mothers deliver themselves, but he should understand when things are not going well, and he now has many clever ways in which to help out the mothers. This is well illustrated by a story told by an English veterinarian. He was called in the night to a farm where he helped a mare to deliver her first foal. The farmer then said, "Cum to th' ole wumon; she's took bad." Next door he looked at the farmer's wife, sat on her bed, and spoke reassuringly while she gave birth to her third girl. The farmer's diagnosis was shrewd: his wife was a multipara and could wait on nature; the mare's foal was her first and nature was stuck.

The baby, while in the womb, is out of reach of our direct interference. The child is absolutely under the control of the mother. If nothing abnormal occurs with her, all should go well with the child. Obstetricians realizing this have for many years now given great attention to pre-natal care. This has paid excellent dividends. One authority tells us that in his state six times as many women died in childbirth fifteen years ago as do now. The death rate for babies has been similarly declining. One hopeful aspect of this problem is that we are beginning to appreciate some of the reasons for the deaths and malformations of these infants, and we can see that it is not just chance. A few years ago we knew nothing of the effects of virus diseases of the mother during pregnancy; of conditions causing the baby to get insufficient oxygen; of the Rh factor. So far we have not taken great advantage of our glimmerings of new knowledge but we are bound to get more light and see our way to saving more and more babies.

**The Rh factor.** Already we are saving newborn infants who are born with a trouble, caused by the much publicized Rh factor, that is called erythryblastosis. This practically means that they do not have good red blood cells. They are jaundiced and have other troubles. The cause is now known and naturally young parents have been disturbed, especially when they think that their two types of blood might cause this difficulty in their baby's blood.

It is not an easy matter to understand the different types of

blood, and the Rh factor is an especially complicated part of the whole story. When the blood from different species of animals is mixed, one blood destroys the cells of the other. Thus attempts in the past to help men by putting in their veins the blood of sheep, for instance, have been worthless. When bloods from individuals of the same species have been mixed (man, of course, is the species that we are interested in), the results at times have been very bad.

Evidently there are substances in some bloods which are hostile to others. We speak of bloods as being of different types and we know that there are many types in humans. Hence before mixing two bloods it must be determined to what type each belongs. If they may be mixed with safety, they are said to be compatible.

Dr. Karl Landsteiner, of the Rockefeller Institute, was a leader in the study of these types. Some years ago he and Dr. Alexander S. Wiener were studying a blood reaction which sometimes makes trouble for the unborn or newborn child. In the course of their experiments they, with that mysteriously reasonable curiosity which guides geniuses, put the blood of a rhesus monkey into a rabbit. After several injections the rabbit's blood developed a substance that, when injected into the monkey, would cause the latter's blood to form in clumps and be destroyed. The same sad result would happen to 85 per cent of humans. Evidently the monkey and most humans had something in their blood which caused this reaction. Dr. Landsteiner as a great compliment to the rhesus monkey, which had been so helpful, called this substance the Rh factor. So everybody knows of the Rh factor but few know of the modest Dr. Landsteiner.

Those persons who have the factor are said to be Rh positive; those who do not are Rh negative. If a father is Rh positive, he usually transmits it to his child. Sometimes some of the child's blood leaks through the placenta and into the mother's blood. If she is Rh negative, she then forms some of the substance which reacts against the child's blood. This substance is called an antibody and is a part of an elaborate system for protection against materials which might do harm. In this particular situation it is hard to see how it is anything but a

nuisance and danger. When it gets back into the child, it attacks his blood. Usually with the first pregnancy it does not make serious trouble, but in subsequent pregnancies more antibodies may be formed with increased potency.

The fact is, though, that only in a small proportion of cases where there is an Rh positive father and an Rh negative mother *does trouble arise. Not all positive fathers transmit the factor* to their children; not always does the blood from the positive baby get into the mother; not always does a negative mother react. At one large hospital there have been about twenty-five cases of erythroblastosis in seven thousand deliveries. The other hazards of pregnancy are greater. As an experienced and wise physician connected with this hospital said: "This factor is nothing of recent origin. It has always been with the race; and the dangers of childbirth, including this one, have certainly not increased. Quite the contrary, but the identity of this Rh menace has recently been established and dramatically publicized." Infants severely injured by the Rh factor are now being saved by blood transfusions.

The premature baby. The medical profession is helping out more and more travelers who have not made a good start through what Dr. Clement Smith calls the Valley of the Shadow of Birth. A baby born much before the full nine months is in a hazardous situation, the hazard being the greater the earlier the arrival. In the past, premature births have been responsible for over a third of infant deaths. It is nice to be able to report that much has been done about this matter and that premature babies are getting a lot better chance.

You see, these babies had planned to spend considerable more time in a very warm, very wet, and infection-free place until they had developed all the parts of their bodies and got them working better. The physicians say that they have "undeveloped physiological responses." They are not even ready to breathe well. Therefore, it is difficult for them to get just the right amount of oxygen, a very important material.

These are all incubator babies, for one thing that these tiny babies cannot do is to regulate their body heat and they have very little to lose. They have lots of water in their tissues and little fat, while a full-term baby has less water and usually a great deal more fat. It is necessary to have the air in the in-

cubators moist as well as warm. The temperature is kept in the eighties but the air is not so dry as in your own rooms.

The babies will stand very little handling and they have little ability to resist infection. For the most delicate cases, hospitals now use a glass box with small openings on the sides so that the nurses may scrub up as they do for operations and, by putting their arms through these holes, may handle the baby without moving him about. Often the babies are too weak to suck and are fed through a tube. They should have breast milk.

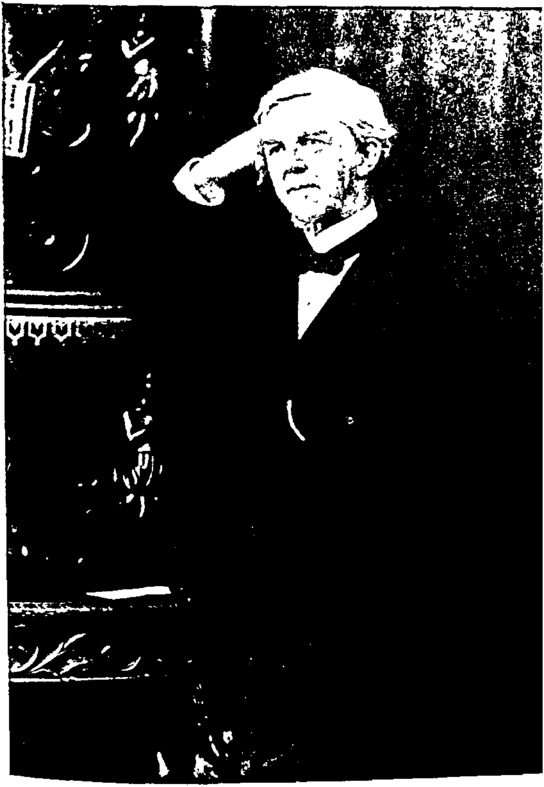
*Breast feeding.* Breast milk is spoken of as the natural food of young mammals. It consists of water, butter fat, milk sugar, some albumen, and salts. Undoubtedly it is the ideal food for the very young, even though the modern pediatrician, obstetrician, and mother have tried to outmode it. Dr. Holmes said that the young mother possesses two globes far better suited for the providing of nutriment for her young than the cerebrum of the wisest professor.

It is not a very heavy diet and it is undoubtedly wise to supplement it after a bit. I believe that many doctors nowadays start some solid food in the first few weeks of life. The milk of the cow has now entirely superseded mother's milk for a goodly proportion of American babies. I doubt if anybody suggests that cow's milk is better for the baby; rather they use the old familiar sales talk that it "is just as good." The argument is all for the "modern mother" who for some occult reason cannot take the strain of nursing as women have done for millions of years. We were brought up on the teaching that nursing was part of the normal physiology of a woman who had just borne a baby. It is said to aid in bringing the uterus back to its original pre-pregnant condition. It delays the return of menstruation. It seems hard to believe that nursing is not worth while.

Not long ago I jotted down (from some source) the statement: "One of the effects of civilization is the fact that a large proportion of human infants have become parasites on the cow." It is claimed that in northeastern United States only 23 per cent of infants are fully breast fed on discharge from maternity units. In England 80 per cent of hospital babies are discharged fully breast fed; ninety-five per cent of those born at home

An advertisement of a baby food states, "The most logical

are on that regimen.



Dr. Oliver Wendell Holmes (1809–1894), from a photograph taken when he was at the height of his abilities.

of it was that the higher the standing of the doctors the more likely was this to occur. Dr. Oliver Wendell Holmes, of Boston, in one of the most brilliant and valuable papers in medical history, on the contagiousness of puerperal fever, showed that this deadly scourge was carried from one case to another by *the attending obstetrician. Childbirth fever is almost unknown* now.

This was undoubtedly the outstanding incident of Holmes' medical career and he had a brilliant one. A member of one of the old "Brahmin" families of New England, he had of course an education at Harvard and Harvard Medical School and, following this, he went to France where medical training was better than that which could be had in America in those days. Here he learned "not to take authority when I can have facts; not to guess when I can know; and not to think that a man must take physic because he is sick."

For thirty-five years he was professor at Harvard Medical School, covering so many subjects that he said his chair was really a settee. To this day these lectures are legendary. Such a training of such a mind led directly to "intensive studies of recorded cases" and "processes of medical logic from which definite conclusions could be drawn." The result was his demonstration that puerperal fever was carried from patient to patient by doctors and nurses. A few years later Semmelweiss in Europe independently reached the same conclusions, and *then Pasteur entirely cleared the mystery by his demonstration* of bacteria as the agents of infection.

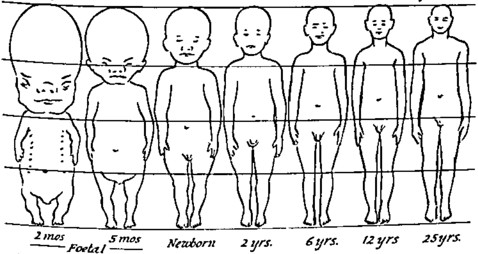
It is well that Americans should be reminded again what a man Oliver Wendell Holmes, Sr., was. *People, including* Holmes himself, have reservations about the versatile man. Holmes himself said, "Do not linger by the enchanted fields of literature — the great practitioners are generally those who concentrate all *their powers on their business.*" *However, Dr.* Holmes did not thus concentrate. Did his literary success dim his medical fame? If he had not written *The Autocrat*, "*The Chambered Nautilus*," and the beautiful hymn "Lord of All Being, Throned Afar," perhaps he would have received greater acclaim as the savior of countless young mothers and one of the outstanding leaders in medical advancement.

## BRINGING UP BABY

In the latter part of pregnancy the child has very cramped quarters in the uterus and therefore takes a position which will result in his occupying the least possible space. The legs, which to anatomists are only the parts from the knees to the ankles, are folded one upon the other. The hips are fully flexed; that is, the thighs are brought up snug against the belly. The knees are also flexed so that the calves are close to the back of the thighs. Then as the legs cross each other the sole of each foot is pressed against the opposite buttock. The feet are rolled in and they are in the position which all of you speak of as toeing in. As the child's head is also held with the chin down on the chest, he comes pretty close to being a ball.

### *Baby's unnatural-looking shapes*

All of this results in the baby, when born, having a shape which just does not look natural to the uneducated eye. The




Figures illustrating changes in body proportions during prenatal and postnatal growth. (*After Stratz. Walter & Sayles,* Biology of the Vertebrates, 3rd Ed., *p. 625. New York: Macmillan, 1949. Reprinted by permission.)*

appearance of the foot is often very suggestive of the ordinary type of club foot. But in club foot the tendons or ligaments are badly contracted and early and careful treatment is needed.

If these specimens of childhood shapes really worry their parents, a gentle moving about of their limbs when asleep will show if they can be put easily into normal position. If that is so, the parents may be reassured that these conditions, which they think are deformities, will gradually correct themselves. Highbred dogs of the most graceful breeds are clumsy puppies to begin with. So it is with humans.

## *Dogmatic rules are no substitutes for judgment*

In the past the rules about the bringing up of a baby have probably been a little bit too severe. Exact schedules, weighing after each meal, with worry over low weight, have been common. On the other hand there may be worry that the baby has eaten too much, although here we are told that babies know when they have had enough and that overfeeding is rare in infants. How we do lose that primal wisdom! Pediatricians tell me that babies are kept too warm and lose weight because they sweat it off. Mrs. Eliza Ann Jane Higgins, for forty years superintendent of the Boston Lying-in Hospital, in her latter days used to go about reaching under the bedclothing and feeling the babies' feet. She said that if the baby's feet were warm, the baby was all right.

Fortunately babies are cuddled more now than they were a generation or so ago. In my intern days, or rather nights, I always had my favorite infant whom I picked up and carried about as I made my midnight visit to the infants' ward. Babies are the better for the human touch and some moving about.

Recently I received a letter from a fond mother in which she asked, "What significance do you attach to a continual rise in temperature (mouth) 99.2 – 99.8 in my six-year-old boy who acts well and eats well? Owing to his negative tests I was told to let him resume his normal activities and throw the thermometer away." In my answer I agreed with the doctor who told her to throw the thermometer away. "Acts well and eats well" pretty well told the story.

Clinical thermometers are of more use with babies than with grownups, for the former can tell us little and examination is all important. Young parents must remember, however, that a

Memling, *Madonna Enthroned.* The baby's head is a miniature replica of a physically perfect man's, far too small.

baby's temperature is not so stable as an adult's and a high temperature may come quickly when the baby is not really very sick. Babies do react with suddenness, either getting sick or getting well, and they usually look the part of health or sickness. Fully as much as with the six-year-old just mentioned, if they act well, they probably are not very sick.

Wild animals, no matter how abundant food is, do not injure themselves by overfeeding. Babies are wild animals and they

A real baby. The head is greater in diameter than the body.

do not hurt themselves by taking too much food. It is usually the wrong food that makes trouble, although it is realized, now, that they can take some more kinds than were previously given them. A gentleman with the Hibernian name of Cadogan realized many of these things two centuries ago and he said that the baby should have as much as it would take from both breasts at each time while he pitied those who were "stuffed with pap til they spue."

Of course he lived in the days when it was taken for granted

that the mother or wet nurse would give the baby breast milk. This pretty well persisted until less than a half century ago. Those who recall Edwardian days will remember that it was not so uncommon for the bosom of the nursing mother to be shyly exposed, whether in drawing room or public conveyance, in response to the infant's need.

There is not one correct answer to any one of these problems. More babies should be nursed than has been the recent custom; an occasional mother has a good reason for not nursing. The baby should have something to say as to when he gets his nourishment; this does not mean that every time he whimpers he should be shut up by the breast or the bottle. He is almost always the best judge as to when he has had enough; but, if he is grossly overweight, remember that almost all grownups and a few babies can get the habit of eating too much.

But in feeding and in everything else dogmatic routines (typical of this perhaps over-organized age) are no substitute for judgment. Routines can be overworked; they are a reaction against the days when the doctrine of laissez faire ("Let nature take its course") was popular. It is now in absolute disrepute. All this is largely evident in the upbringing of children. Regimentation is not only overdone in infancy but it is carried on into childhood and even adolescence. It was formerly said that the cat was the ideal mother. As long as her kittens really needed her, they got unremitting attention. After that, they were cuffed and sent on their way.

Fifty years ago the method of the cat was somewhat applied to human children. When school-time came, they were started out in reasonable condition and were expected to get themselves to and from school. There was no transportation even for Bill and Lena Johnson, who lived two miles away in the woods, or for a scion of wealth who had the same distance to go in New York City. Had the words "supervised play" been uttered on Cape Cod they would have been meaningless to our more than ordinarily intelligent parents. But a generation back, the organizers began to take hold. Twenty years ago the mother was not allowed to pick up the crying baby and pet him, and she was expected at all costs to get him clean in the first year — and preferably in the first month of his regimented

life. Today she is encouraged by some doctors to pick him up the minute he cries, and to let him get clean at his leisure.

### *The baby's sleep*

An able pediatrician told me a few years ago, "There are three things which you cannot make a baby do — pee-pee, eat or sleep." We can cooperate but we cannot force them. Newborn babies devote their lives to eating and sleeping. In fact, it may at times be almost impossible to awaken a small infant. A child of three is likely to be a nonconformist. He may insist on his own ways, which are difficult to change, and one must be careful because a great deal of trouble may be caused by trying to force him. Threats will not avail, but careful and assiduous attention to some details will often help.

The mother of a delightful miss of one and a half years never says "no" to her baby. There are many subtle ways to get the desirable result without the use of the undesirable word. Just as the sight of my dog was associated in the child's mind with "wow-wow," so the word "no" would soon be associated with denial of things which she desired. So, when told to go to bed, she smiled sweetly as she did not know "no."

Rigid schedules are probably not good for most children. Do not insist that they always retire at 6:30 P.M.; advance the time or retard it to a certain extent according to the child's state of mind.

In recent years I have had a striking illustration of good results with a child who was many hours off what is considered the normal schedule. Our week-end parties at a ski lodge usually meant dancing, loud music, and lots of excitement up until midnight. Young Jackie, the son of the manager, was always around during a good part of it. He would retire hours later than the usual child; then he slept throughout the breakfast hour, which was another busy time for his parents. Necessity led to a complete rearrangement of his sleeping schedule but it was evidently perfectly satisfactory.

Gesell, the ultimate authority on children's behavior, says that it is normal for children to have sleep difficulties. Parents should recognize and not aggravate the situation. Studies of

sleeping children in recent years have shown that country children sleep shorter hours than city children, but also that neither group comes up to the standards somewhat arbitrarily established by their parents and pediatricians.

## *Bed wetting*

Our pediatric friend says that you can't make a baby pee-pee. I think that you will agree that this is rarely a source of complaint, but that the frequency of this function is the routine cause of disturbance to mothers. I have often been asked by mothers how they could break their children of the habit of bed wetting. *Within a few weeks of this writing I was approached by an anxious mother with this and other associated problems.* I consulted a pediatric friend of great experience and then advised her essentially as follows: It is evident that you have worried and fussed over these children but have not been rigorous enough with them. Do not punish them but insist on a regime by which they can work out the problem themselves. When you go to bed, make them get up and go to the toilet whether they wish to or not. Set an alarm for the early morning hours and again make them get up. Anyone who offends must wash the sheets. The boys especially will be impressed by this. It is not manly to wash sheets and it is more conspicuous than what leads up to it. No special diet. Do not force salt on them; neither keep it away. Perhaps this will make bother for you at first, but I predict that you will soon even up. She did.

## *Eating problems*

The normal child's appetite may fall off from time to time, often worrying the mother considerably. She coaxes and threatens and finally mother and child, exhausted with the perpetual fight, end up in the doctor's office. If no organic disease is found, it is often just a case of a smart attention-desiring child and a doting parent. The children who "won't eat" but who manage to worm several soft drinks a day are a common problem. Sometimes parents deny these sweets to their children

but neighbors feed them. It is a good rule for friends never to give sweets to a child without express permission from the parents. Common sense will cure most feeding problems of children.

## *The "delicate" child*

For many years I have been sceptical about children who were too "delicate" to do this, that, and the other thing. 'Way back in my youth one of the boys of the village, whose family was comfortably fixed, was so delicate that he "could not eat" beefsteak. This was ridiculous. Beefsteak is one of the most easily digested foods that we have.

A country medical officer a long way from these parts has written about the matter and rather blamed the doctors for their part. He thinks that they have been especially wrong in the way they have made diagnoses in children. The parents will tell the doctor that the child has had "breathlessness on effort since infancy." It is a perfectly normal thing for a child to run about until out of breath, but the physician who has been told of the breathlessness may have heard a heart murmur and advised the parents that the child must be restricted in his exercise. Perhaps in the old days physicians were justified in worrying about heart murmurs but modern studies with electrocardiograms and other scientific devices have shown us that many heart murmurs are of no importance whatever. The son of one of my doctor friends had an unusually loud heart murmur, yet he has climbed the Matterhorn and even more difficult mountains and is still going strong.

Children have been kept away from school for long periods because of bronchitis and worry as to whether they were tuberculous. With X-rays and modern diagnostic methods it can be determined pretty certainly whether or not a child is tuberculous. If he is, he needs much more definite treatment than being kept away from school. In nearly all such cases absence may contribute nothing to health while interfering with success in school.

But though a tuberculous condition does demand specific treatment, normal people are entitled to certain normal pains,

among which stomach-ache can be a normal diagnosis. I wonder how many times we children were given Jamaica ginger and hot water, nicely sweetened, for stomach-ache. Not so dangerous as a cathartic. I knew one little girl, an only

An electro-cardiograph in operation. Forty years ago the apparatus filled the entire room.

child, who had many attacks of stomach-ache until her mother finally realized that she had been babied too much, and this was her way of preventing absences from her doting mama. All this is no argument against taking care of sick children, but being delicate is no diagnosis and does not need much treatment.

If one were to list the branches of medicine according to the degree of development of the individuals concerned, the order could well be: veterinary medicine, pediatrics, and the medicine of adults, with this latter including old adults as well as middle-aged ones. The child is mighty close to what we refer to as dumb animals. As far as the young child himself is concerned, the mind is very little, if any more, developed, and the body much less. The problems of the pediatrician have to be solved with little help or hindrance from the patient.

The pediatrician demands and expects more from the nurse than does the physician caring for grownups. The ideal nurse should be the mother. Recently, in fact, *The Lancet,* the old and wise medical magazine published in London, has urged that even when children are taken to the hospital for operations, they should be nursed by their mothers.

## *A challenge to parents*

All this has to do with the physical side, but if one is to believe thoroughly what one reads in modern psychiatric writing, the offspring, personally conducted by the mother through the early part of life's journey, often is wrecked on the Scylla of personal animosity or the Charybdis of too much attachment and dependence. It seems hard to believe that many mothers actually dislike their young children and act accordingly. More often it is an example of a common human failing, the overdoing of a good thing.

The mother, who of necessity must absolutely dominate the infant of a few months, may arouse resentment if she continues to do so when the child is developing its own ideas and most naturally wants to be on its own some of the time. Also the emotional, fussy mother, changing her child's apparel every time the sun goes behind a cloud, or producing a thermometer whenever the child's face is red from exercise, may be very exasperating and upsetting to the child's equanimity.

Healthy youngsters can stand a good deal. If they are sick, they show it by their actions. In my early manhood I wondered at children playing for long hours in the cold water of the North side of Cape Cod, which quickly chilled me. Some of them are healthy grandparents now.

What were formerly the gravest dangers to childhood, the infections, have been largely eliminated in a lifetime by sanitation, assisted in the last few years by the new drugs. I am speaking, of course, of the more fortunate parts of the world. Children now have an extraordinary chance to grow up. The problem from here on in is to train the parents so that they will train the children that they may justify the upbringing.

### *Nature's marvel*

Any child at birth has progressed a tremendous distance since the instant when the sperm united with the ovum. Quantitatively, the multiplication of its cells has gone into astronomical figures; the growth by division of this living matter is one of nature's marvels. Qualitatively, the diversification of the cells, all coming from the original union, is still more incomprehensible. We can get faint glimpses only of why some cells turn into long black hair, others into a powerful heart muscle, still others into a brain that may turn out to reason as wisely as a Darwin. How are all these diverse, complicated possibilities contained in a sperm and an ovum? The part of man's brain, which is the home of the higher intellectual activities, contains an estimated nine thousand millions nerve cells, but he cannot answer this question.

# 2. Featherless Biped

## SKIN

THERE IS NO PART OF US WITH WHICH WE ARE SO WELL ACquainted as our skin. It is in plain view, theoretically at least, and actually, with the revealing costumes of modern styles. Even the inside of the mouth, which we can easily peer into, is lined with a modified sort of skin, and the teeth are formed from it, as are numerous glands. Our class in the animal kingdom is named after the most prominent of these glands, the mammae, or breasts.

It is not remarkable that man has been popularly subdivided according to his most familiar aspect, the color of the skin. So we have the white race, and in this country the red man or Indian, the yellow races of Asia, and the blacks of Africa. This is certainly not a scientific classification and I am sure the anthropologists do not attach undue weight to this one factor. Nevertheless the result of untold centuries of strict breeding has been that Negroes, for instance, who have under

the surface of the skin enormous quantities of brown coloring matter, will continue to have offspring of the same color. That is, unless the offspring intermarry with whites.

The skin is adapted to more purposes than any other part of the body and cannot be duplicated even by our ingenious modern machinery. Who can create a tough but highly elastic fabric that will withstand heat and cold, wet and drought, acid and alkali, microbic invasion and the wear and tear of three score years and ten, yet effect its own repairs throughout and even present a seasonable protection of pigment against the sun's rays?

## *The skin retains body fluids*

Undoubtedly, the most important function of the skin is protection and it achieves this for us in many ways. First, by any rating, is the prevention of the drying up by evaporation of the fluid which protects all the live cells of the body, since cells have to be wet to live.

Life began in the sea many millions of years ago. That sea was salt and ever since, all animal life has existed in salt water. Water performs its important duties because there is nothing else that will hold so many different substances in solution. Dr. James L. Gamble, a great authority on the fluids of the body, says: "Before our extremely remote ancestors could come ashore to enjoy their Eocene Eden or Paleozoic Palm Beach, it was necessary for them to establish an enclosed aqueous medium which could carry on the role of sea water." That is why the skin was formed so early in the development of animals. Fluid will not soak through skin any more than it will soak through leather, which is tanned skin. So we are living, all wet, in a water-tight container.

The body is composed of an enormous number of units called cells and every cell is saturated with fluid. This fluid within the cells comprises about 50 per cent of the body weight. The fluid surrounding the cells might be considered for each of us as our share of the Cambrian Sea, from which our progenitors emerged. Part of it is in the blood and part is in the lymph. If you have ever raised a blister, you have seen lymph. All

this fluid outside the cells comes to 20 per cent of the body weight.

The function of the body fluid is to assist in what we call metabolism. This is the infinite number of chemical and physical changes which occur in the body as long as life persists. Substances are taken into the body, changed as necessary, and transported by the fluid to where they build up the protoplasm, the material of which the cells are composed. Then as protoplasm is continuously replaced by new, the old waste products are carried away.

To keep the chemical composition and the physical properties of the body fluids delicately balanced is an intricate piece of work. A lot of apparatus had to be assembled for this as the body grew. The heart stirs and moves the fluid about. The lungs handle the relations of the gases in the atmosphere and within our bodies. The kidneys excrete substances that we do not need and help maintain the chemical and physical balance.

The chemistry of the body fluids is extremely complex. The sea water is referred to as salt, and to most of you salt is the common table salt, sodium chloride. Had you visited the salt works of Cape Cod in my youth and tasted the brine produced by evaporation, you would have realized that there were other salts in it: Glauber's salt and Epsom salts, for example. Still, sodium chloride is easily the chief one as far as bulk is concerned, both in the ocean and the extra-cellular fluid of the body. But in the intra-cellular fluid potassium chloride has replaced it, although only a gossamer membrane separates the two fluids.

Those of you who have recently been hospital patients realize that treatment by introducing fluids into the veins is much employed. This is undoubtedly a great advance but an enormous amount of research has been required to bring it about and extreme caution in its use is necessary. The tissues do not take kindly to pure water, and the most common fluid used is weakly salted water—just the strength of the body fluids inside you. (The fluid in the body has 0.9 per cent salt. This is the strength which we inject into the veins. We call it normal salt solution.) The variations from this starter are many, but they are all guided by a desire to keep the tissues of the healthy

body bathed as though it were still floating in the primitive ocean.

Any cells which dry out, immediately die. All we see of the skin is the epidermis. This consists of the cells formerly living beneath the surfaces which have now died and dried. They are as inanimate and insensitive as the shell of a turtle. They are used ingeniously by the skin as a protection for the live layer of skin underneath, the dermis.

The fact that the skin retains the fluid surrounding all our cells so it cannot get out, and the fact that no matter how long we soak in water, little gets in, may not seem to agree with your experience in sweating. Sweat is, however, a definite secretion of the sweat glands, used chiefly to regulate the heat of the body. This will be described later. When our sweat pours out, it does not mean that any fluid surrounding our body cells is evaporating or escaping.

## *The skin protects delicate tissues*

The skin is a protective covering often referred to as a garment: a most incomplete metaphor. It is such a one as no Parisian modiste or Bond Street tailor ever devised. It adjusts itself to all seasons. In the winter by various clever schemes it saves the body all the heat possible, while in summer it has ways of radiating heat. Its texture varies in thickness as necessity arises. It actually covers the eyeballs but is of extreme thinness here, thus offering little obstruction to the passage of light.

At areas subjected to great chafing and wear there is corresponding thickness. The tough soles of barefooted people and the horny-handed manual laborer are familiar to all. Sad experience has taught the danger of blisters when soft skin comes in contact with heavy tools. When the chafing reaches a point where the tough outer layer can no longer afford enough protection to the delicate inner layers, nature comes to the rescue with what the medical men call a bulla, but what we run-of-the-mill people are all too familiar with as a blister. As you know, the live tissues are always saturated with a thin fluid. This collects between the outer and inner layers, and although

we do not like it, nevertheless it affords much protection to the tender tissues beneath. But if the skin is allowed to accustom itself slowly, the responsive thickening is certain.

Dr. Francesco Ronchese, of Providence, Rhode Island, has a most interesting little book with many illustrations, called *Occupational Marks.* Habitual pressure of a tool will produce a heavy callus at a typical position. The modern increasing use of mechanical gadgets must modify these marks. Still the professional boxer, particularly if he is a "ham," will probably show cauliflower ears. The granite cutter for years has used power-driven chisels and will continue to have a ring of callus around his little finger.

Soon after 1890 Mark Twain wrote his book about Pudd'nhead Wilson, the story of a lawyer in a Mississippi town who became interested in the whorls and marks in the skin of the finger tips. A mulatto women changed her son with the white child of the family where she worked. Pudd'nhead finger-printed the children in infancy and when the grown-up pseudo-heir committed murder years later, he was identified by his finger markings.

Evidently Mark Twain learned early of the work that led later to the almost universal finger-printing in modern communities. These markings are friction ridges found principally on the finger tips where we do so much grasping and they help to prevent slipping. Once again our pride is humbled as we learn that certain monkeys have such friction ridges in their prehensile tails. These ridges extend into the depths of the skin, or rather vice versa. When Jimmy Valentine sandpapered the tips of his fingers to get more delicate feeling, the ridges soon grew back in the same underlying pattern.

Dr. Ronchese points out that in rare cases the typical markings may be absent, owing to leprosy in the tropics, radiation by X-ray or radium, and even skin grafting. Then occupational marks might well be a help in identification.

The nails are really not a great deal different from the hard outer layer of the skin, being formed in much the same way. The tips of the fingers are tremendously important to us and they are very sensitive and exposed to injury. That evidently is the reason why at these places, instead of hard heavy calluses,

the dead remnants of the live cells are packed tightly together to form the nails. At the upper end of each nail is a thick collection of live cells just below the surface. This is called the matrix and is the growing part of the nail. As these cells die, they are pushed along the bed of the nail. You are all familiar with the process as you find it necessary to cut or file off the lower end. It is said that nails usually grow at the rate of two inches a year.

If the whole nail is pulled off, a new one can thus be formed in a few months and theoretically it should be just as good as the old one. If any part of the matrix is destroyed, however, the scar of this will always show thereafter in the nail. Any injury to the nail itself, as by nail polish, is a temporary affair; therefore, it is on the whole a harmless if barbaric practice to use modern beauty aids here. Similarly, nail biting is not a serious habit except from the aesthetic point of view.

Even in portions of the skin not subject to extreme wear and tear, there is an astonishing thickness and toughness. I have often been surprised when operating on children of two or three years to find how much skin there is to get through. Just below the horny layer is the real growing portion of the skin. The cells here continually reproduce themselves, not only rebuilding the outer surface but forming the sweat and oil glands and the hair follicles. All these grow down into the deep layers where their working parts send up to the surface their familiar products.

These inner layers called the dermis are, except in those places where calluses exist, much thicker than the outer layers, the epidermis. The dermis is a sort of felt of connective tissue, fibers, fat, blood vessels, nerve endings, and organs for the special senses of touch, pain, heat, etc. In most places it is loosely attached to the underlying tissues, and, as it contains many elastic fibers, it moves freely, allowing a snug fit, whatever position the body assumes. This moving and fitting is helped by the underlying fat which is found in most parts of the body. Females, no matter how slender, possess more of this superficial fat than do their men friends. This accounts for the graceful curves so much admired in that sex and presumably also makes their skin fit better than that of the male. At the

soles, the palms, the scalp, and over the cartilages of the ear there is a firm connection between the skin and the deep tissues.

As the skin grows old, the elastic fibers disappear. An elderly gentleman with parchment-like skin may take a compensatory advantage of this by playing a pleasant parlor game. As a partner he selects a velvety-skinned maiden of, say, sixteen. A referee with a watch stands by as the oldster pinches his own skin into a fold on the back of his hand and then releases it. When the customary ten seconds allowed in the prize ring have passed and the ridge probably has not returned to the normal position, then our septuagenarian pinches his young companion's skin. When released this will return to its former adolescent appearance before the referee can count at all. The elasticity of the protective garment is both practical and aesthetic.

In two little areas, the skin does a special protective job. At these spots, and these spots only, it excretes cerumen. This is the familiar wax of the ear canals. As these canals are a great help in collecting sound waves and carrying them in through bones to the middle ear, it is highly important that they be protected. Dirt, insects, and other noxious agents could make a great deal of trouble were it not for the wax which helps to keep them out and also protects the skin of the canal which otherwise would undoubtedly be always soggy with moisture. We don't pay much attention to this wax except when occasionally the body does too good a job and develops too much of it. Comparatively few people ever have to worry, but when the accumulation is too great, it has to be washed out. In my day at the Massachusetts Eye and Ear Infirmary one orderly handled all such treatments and developed a technique far beyond that of any of the learned otologists.

**Hair, the loss of hair, and hair tonics.** The hair evidently serves as a protection to those animals which possess it. It cushions blows, and takes up chafe; it holds the warm air about the body in cold weather and wards off the ultraviolet, the burning rays of the sun, in the summer. (Don't clip your long-haired dog in July and August. His tender skin needs the shade and he does not give off heat through the skin as you do.)

Of course human beings do not really need their hair as their

remote ancestors did. They have learned to fashion garments which take its place. Any physician can name a number of people who have suddenly and completely lost their hair, even their eye lashes and the hairs inside their nostrils. Except for the reasonable unhappiness over their altered appearance, they are not apparently any worse off.

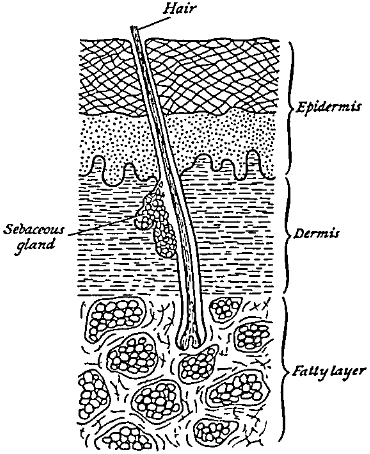
Hair in humans is now a distinguishing sex characteristic. Yet the "crowning glory" of womanhood is exclusively theirs only by the forbearance of their male friends. Witness the picturesque appearance of Buffalo Bill or the Stuart Cavaliers. The "beard of goats and men" does establish pretty accurately the sex of the wearers, and an abundance of hair over the rest of the body is fortunately the proud possession of males. The two sexes are distinguished by the arrangement of pubic hair. That of the male comes up in a triangular shape to the umbilicus while in the female it stops short at a transverse line just above the mons veneris, the prominent pad over the bone at the lowest part of the abdomen. In certain disturbances of the endocrine system, that is, the glands of internal secretion, the male is apt to have a female distribution of hair, and vice versa.

It is evident that human hair is a great source of worry. Most of the worriers are bothered by its loss; a few by the presence of too much. For those who have too much, treatments with an electric needle can kill individual hairs, and X-ray will remove the hair. This latter is a tricky procedure and should be used only by competent X-ray physicians.

For the other side of the story: if the hair begins to come out so as to leave irregular bald spots, then see a skin specialist. It might be ringworm, or alopecia areata. The Greeks thought that a person who had patches of baldness looked like a mangy fox so they gave the name "alopecia areata" to the condition. This does not refer to the shiny pates so common in our middle-aged and older men. Often, of course, small spots of baldness are due to ringworm or other infections. The spots we are referring to have no evident cause.

Alopecia areata may appear in men, women, or children; in men twice as often on the back of the head as the front. Just the opposite is true with the women, but, possibly because of

the way women arrange their hair, it is not noticed in the back. So, as women are smarter than men in covering up their blemishes, we can't judge well which sex is more afflicted. Statistics would seem to show that lately alopecia is becoming increasingly frequent in England. Once again statistics are deceiving. In England, since the government took charge of




Cross-section of skin showing a hair. (*After J. C. B. Grant,* Method of Anatomy, *p. 70 Baltimore: Williams & Wilkins Co., 1952.*)

health, eye glasses, false teeth, and wigs are furnished by the Ministry of Health. People who have been resigned for years to baldness are now trying out wigs at the government's expense.

In alopecia areata it is common to have a partial loss of hair and recovery. These are the cases that have encouraged so many people to believe that the application of the proper hair tonic will favorably influence their baldness. But for those who

just gradually get bald, their misplaced optimism has made the fortunes of manufacturers of hair lotions. I have received many, many questions about the hair. There is still the belief amongst many people that local applications may cause hair to grow on bald spots or improve the health of the hair. You have been told that the hair follicles where the hairs actually grow are in the deep layers of the skin. The hairs themselves are dead matter whose appearance may be changed by dyes or other treatments. Rarely, I believe, are the deep, live parts injured by these materials and never, I think, are they helped.

You may get some impression of the blind credulity of the public when you learn that one chain of "hair experts" has a yearly income of nearly four million dollars. Often treatments are given with massage with the idea that there will be an increase of blood supply and this will cause the hair to grow. Any bald-headed man who has received a deep cut on his scalp should be convinced that there is plenty of blood circulating there.

Few things in our daily life seem more foolish than this unintelligent attitude towards the hair. Even the most brilliant minds are weak in this respect. On our college football team was a dashing halfback with the blackest, most luxuriant head of hair in the group. The brain beneath was in many respects as much to be admired; yet a few years later, after he had the benefit of a medical education, he began to grow bald and spent his money for hair lotions to bring back his fading glory. He is even balder now.

I realize that anything I say will not affect the sale of hair tonics. Years ago, when Dr. Greene's was a popular patent medicine, some exasperated doctor exclaimed that it never did anybody in the world any good. The reply from the manufacturer was: "You are wrong. It has done Dr. Greene lots of good." It is not at all unusual for a skin specialist to be bald. Choose your grandparents from those who did not lose their hair.

## *The skin controls ultraviolet radiation*

There is one other way in which the skin gives protection and that is by limiting the amount of ultraviolet sun rays that

get through it. These rays in proper amounts are necessary for the formation in the body of Vitamin D, which most of the world were willing and obliged to obtain without the seal blubber diet of the Eskimo or the dubious flavor of cod liver oil. The body is normally not gluttonous. Until habits are improperly developed, it does not want too much of anything. The sun, however, does not cooperate. In many climates it furnishes ultraviolet radiation in deadly doses. The body's defense is to deposit in the skin a brown material called melanin. In sufficient amounts it stops the harmful rays.

In Africa a race has developed born with plenty of melanin. The summer girl on our beaches, however, had best take her sunshine in small doses for she slowly accumulates the coloring material. None of the protective lotions will do a perfect job for her.

In recent years much has been written about the long-range danger of exposure to the sun. We are told that skin cancer is more common with such occupations as farming and fishing. I am in no position to deny this claim, but in some twenty five years' attendance at a tumor clinic where there have been many skin cancers I would say that I have met few farmers or fishermen. But then I live in a city. The open air life I believe to be, on the whole, healthy as well as happy. One cannot take it conveniently the year round without a protective summer tan, so I always try to get one.

## *The skin regulates body heat*

The skin helps keep us cool in summer. The elaborate chemical reactions inside the body result in much heat which is continually being given off, for otherwise the internal heat would rise above 98.6° Fahrenheit, which is the average temperature necessary for the human body.

The feces and the urine carry away heat, so does the breath. The skin, however, does the bulk of this work. Radiation accounts for a good deal. Any warm object gives off heat to the surrounding cooler air—your cup of tea, for instance, if you do not drink it quickly. The skin is abundantly supplied with blood vessels and when these dilate they bring warm blood to the surface where it loses heat. This loss, of course, in all

except the hot parts of the earth, was originally the reason for wearing clothing. With absolutely still air, little heat is lost from the body even on cold days. People who go in for winter sports know that wind chills more than colder, but quiet, air. It removes quickly the thin layer of air which the body has warmed. So an outer garment of closely woven cotton is more efficient than a heavy sweater through which the wind whistles.

## *Sweat*

In the average human body there are several million sweat glands, and through their tiny openings a mixture of water, salt, and waste products is secreted or excreted. These glands are in the deep layers of the skin where their coils, as Dr. Oliver Wendell Holmes said, resemble fairies' intestines.

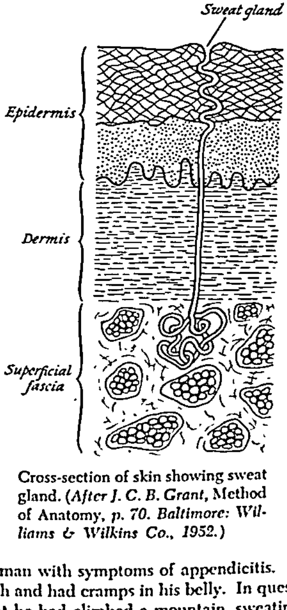
The ancients who wrote the Bible were careful observers. Adam and Eve were told: "In the sweat of thy face shalt thou eat bread." The distribution of sweat glands varies greatly. The face is one of the places most amply supplied, as any surgeon can tell you. Sweat pouring off the brow and into the eyes may be a most disturbing accompaniment of a difficult operation. The physical labor of shoveling sand produces no more sweat than the concentration of an operation in which there may not be five pounds of actual lifting.

For most of us most of the time, the chief problem is to dissipate bodily heat, and the chief agent for doing this is sweat. We sweat all the time, getting rid of a pint or so daily by "insensible" perspiration, which is evaporated so quickly that we do not feel damp. Evaporation requires heat and this is removed from the warm body. For an extreme example of this, pour a little ether on your skin. Ether evaporates almost instantly, causing your skin to be ice cold.

Long continued heavy sweating removes large amounts of water from the body. Likewise it takes away lots of salt. Too much of this results in what we call "heat exhaustion." The balance of sodium, potassium, calcium, and other materials in the fluids of the body is very delicate. Common salt is sodium chloride and is easily one of the chief constituents of the body. If you have ever had blood in your mouth, you know that it

tastes salty. It is well to emphasize these facts, because popular medical literature and much medical practice have of late been emphasizing the virtues of a low salt diet.

Three years ago I spent a week with a group in the mountains. One evening after a terrifically hot day I was asked to




Cross-section of skin showing sweat gland. (*After J. C. B. Grant,* Method of Anatomy, *p. 70. Baltimore: Williams & Wilkins Co., 1952.*)

see a young man with symptoms of appendicitis. He was sick at his stomach and had cramps in his belly. In questioning him I learned that he had climbed a mountain, sweating profusely all day, and had been able to get little water to drink. I decided against appendicitis, started him carefully on small amounts of water and salt until his nausea had ceased, and then increased them to liberal amounts. In the morning he

had entirely recovered. Had we been within reach of medical facilities, some salt solution put directly into his veins would have done the job promptly and more certainly.

On this same expedition was a man with a lifelong disturbance which prevented him from sweating. Hence he had to be exceedingly careful in hot weather that his temperature did not rise to a dangerous point. Sweating is regulated by sympathetic nerves. I have seen a man, with an injured nervous system, one half of whose body was bone dry while pools of sweat stood in every little hollow of the other side.

Probably all of you have found yourself sweating when placed in an embarrassing position and so know that the emotions play their part. Intense enjoyment of food often causes a local sweating of the face, called gustatory perspiration. Boswell said of Johnson, "While in the act of eating, the veins of his forehead swelled and generally a strong perspiration was visible."

**Miliaria, or prickly heat.** Sweating is a beneficent thing for us, but men are obtuse and often unappreciative of their blessings. There are unpleasant aspects about it. One of its disagreeable associations is prickly heat. The dermatologists, wonderfully clever in nomenclature, call this miliaria, because the spots seen on the skin are the size of millet seeds. Probably neither you nor I have ever seen a millet seed so we cannot dispute the reasonableness of this name.

The sweat glands are deep in the skin and send their mixture of water, salt, and some of the body's waste products up to the surface by long narrow tubes. The openings of the tubes are mighty small so that it does not take much to block them. The sweat, continually forming, pushes up the plugs and gives an appearance of little blisters. Usually these break easily but if they get firmly plugged and inflamed they bulge and turn red. They tingle and burn and hence are called prickly heat. Most people fear cold, and fond mothers are especially certain that it is a grave danger to their offspring. So they swaddle the poor youngsters, and prickly heat results.

The treatment is theoretically simple: stop sweating. But tons of lotions, powders, and ointments are expended yearly in the fight against miliaria. Any irritable effects they have on

the skin are rapidly transformed into more plugging of the sweat glands. Wear light, airy clothing, clear everything off the skin, and there will not be much prickly heat. All this is a striking example of what is very common, over-treatment of skin conditions.

**Non-perspirants and deodorants.** Sweating is, strangely enough, one more of the many things which distinguish us from the brutes. You know that a dog does not sweat but cools off through his tongue. Cats are said to sweat only on the pads of their paws. It is hard to see what good that does them. Old people who drove horses in their youth, and younger ones who frequent the race tracks, may know that horses sweat all over as we do. But in their thousands of years of association with us as our servants they have not been allowed to adopt the habits of civilized men, and there seems to be no evidence that they are much disturbed by sweat.

We of the "upper classes" are much disturbed, especially by the discomfort of sweat-soaked clothing and what certainly does not disturb the brutes, the bodily odors arising from perspiration. For centuries fastidious people could do nothing but attempt to drown out these odors with perfumes. Even today, many of us, when our nostrils are assailed by expensive perfumes, cannot rid ourselves of the feeling that under the scents of Araby is the human effluvia.

The commercial people, who never miss a chance of gain, long ago began to sell us preparations which they claimed would stop the sweat, and, what is certainly painting the lily, would stop it from smelling. Fortunately for us they do not stop the sweating. Normal persons are bound to sweat. Since this fluid is secreted by glands in the depths of the skin, applications on the surface do not reach these prolific springs. For a long time there have been deodorants on the market. As a large proportion of you are city dwellers, and, because a constant reiteration of a statement, rather than the logic which should be back of it, is the basis of a selling campaign, it is not surprising that most of you a few years ago bought chlorophyll preparations to remove your body odor. How were you to know that cattle, horses, and goats, in an ascending scale, reek with strong odors, even though they steadily consume chlorophyll

during most of the year? Many carefully conducted experiments by scientific observers with no axes to grind failed to show that odors, either disgusting or delightful, are decreased by chlorophyll.

The axilla, or armpit, is the portion of the body which has attracted the most attention by its disagreeable sweaty odor. Recent investigations have shown that there is a good reason for this. The armpit has an unusually large number of sweat glands. Many of these are the kind that are found all over the body and you may be surprised to learn that the fluid they secrete is said to be odorless, or at least inoffensive.

There is another group of glands found in the axilla that are supposed to be stimulated by the emotions. Many of you must have noticed how the sweat absolutely runs down from your armpits when you are nervous. Our clever, skillful investigators were able to put minute tubes into these glands and collect pure sterile sweat. Surprisingly, this sweat had no odor and, if kept sterile, developed no odor in a fortnight. But, if this sweat was allowed to stand for several hours and became infected, the characteristic odor developed. So there you have the answer. There are bound to be bacteria in the armpit, as a warm moist place is ideal for their growing. As bacteria do everywhere, they break down the substance on which they grow with the formation of new substances. Some of these smell.

Many antiseptics have been sold to kill off the bacteria. They are not practicable. Antiseptics are rough, and, if they are rough on bacteria, they are also rough on other live cells. Many people have got into trouble by using such irritating materials under their arms. Besides, bacteria have ways of getting into crevices of the skin where the antiseptics do not reach them and they thrive there and produce the odor.

So what are you going to do to keep yourself dainty? Shaving the hair will help, for bacteria gather here and are hard to clean away. Most women have long done this but I have not known of men doing it. Sounds sort of sissyfied.

The majority of women use some commercial non-perspirant and deodorant, especially under the arms. The basis of practically all non-perspirants is alum, which has a puckering action on human tissues. This is supposed to tighten down the outlets

of the sweat glands, thus stopping the perspiration. It may decrease but it most certainly will not stop the flow of sweat. In regard to destroying disagreeable odors, there is little scientific evidence that the so-called deodorants actually do this, but they undoubtedly cover up the odors. If I were a fastidious woman, I would probably use some of these preparations. Such women are convinced that they do good, and perhaps science has not conclusively settled the question. But I would watch carefully for danger to my skin as some of these preparations do much harm to some skins. Cleanliness is the absolutely necessary basis for daintiness. Wash frequently with non-irritating soaps and change clothing frequently. Fastidious people have long done this without being told that it was scientific—just sensible.

**Soap and water is the best antiseptic.** It is such cosmetic and aesthetic effects that most of us associate with the use of soap. We consider that one of the most striking differences between modern men and the best of the ancients is our enormous employment of this cleanser. We are told that the average American consumes about twenty-five pounds a year.

I wonder if its tremendous value in medicine is fully appreciated. Forty years ago my famous professor of hygiene said that soap and water is the best antiseptic. That is now well understood by modern medical men, even though there are some bacteria that soap solutions do not kill promptly. Bacteria removed from the body are just as harmless as though they were killed in situ. To build up the evidence I will quote from a recent book on soap, edited by Dr. Morris Fishbein: "No other single article can compare with soap in regard to the amount of sickness and death prevented by its use. Epidemics rage where soap and water are little used for personal and domestic purposes." Two centuries ago Dr. Samuel Johnson said that if he were to keep a seraglio, he would keep his women in cotton rather than silks, as cotton showed its own nastiness. By inference he suggested that cotton was amenable to cleaning by soap. Over a century later physicians and hospitals realized the significance of this remark made by a doctor of laws, and clean cotton is now an essential with them.

It is strange to find that many people do not know how to use

soap efficiently. Here is the proper recipe. A thick suds should be formed and rubbed in thoroughly for a considerable period, allowing the dirt to be softened and freed from the skin. If there is much dirt or extreme cleanliness is desired, the process may be repeated, but the suds should never be washed away quickly before they have done their work. Mother's old washerwoman on Cape Cod, after looking at the black roller towel, would say, "You boys had a dirty wash and a clean wipe."

Within the lifetime of those who are now becoming grandparents the bathtub with running hot and cold water has become the very hallmark of the American. In my country village I think my mother put in nearly the first one. Before that the Saturday night bath was an institution. A big fire was kept going in the kitchen range, the wooden clothes tub was brought in, and the family took turns.

Nowadays people are rather diffident about admitting that they don't have a daily bath. This is an exaggerated attitude. In fact there are a fair number of people with a tendency to dry skin who just cannot take it. Hot water and soap remove the normal fat, provided by the glands of the skin, to such an extent that they chap, itch, and are exceedingly uncomfortable. Even normally greasy people can get along with a moderate amount of soap and water.

Recently I was at an isolated skiing club where trouble with the water supply allowed no baths for four days. I do not think that we smelt strong and we were comfortable. Right here I must forestall cynical remarks by stating that I get well over three hundred and sixty-five baths a year myself.

Also remember that although soap is of great medicinal value, "medicinal soaps" are not worth while. Soap is soap and does its work by cleansing and not by the chemicals that are put in it. If you want a nice smelling soap with perfume, pay the price and have it, but understand that the well-known, inexpensive, mild American brands are as good as money can buy.

## Diseases of the skin

The skin may be afflicted with so many diseases that one might think that it has little protection against infection, yet we

have reason to believe that the intact skin is germ-proof. We know now that for centuries surgeons carried infections on their hands and, when they operated, it was taken as a matter of course that the wounds would become infected. Then Pasteur showed that infection was due to germs, and Lister of England demonstrated that these infections were carried by the surgeons. Meanwhile the surgeons were fairly safe themselves. If they refrained from sticking needles into their fingers or cutting themselves with scalpels, it was their patients and not themselves who died of erysipelas or pined with suppurating wounds.

But a skin without the slightest break through its surface is a difficult thing to achieve. A bacterium is exceedingly minute. Wounds invisibly small may let a horde of them into the moist warm flesh where they thrive. Even the surgeon's eagerness to obtain great cleanliness may itself defeat his purpose. Frequent washes with soap remove the soft grease normal to the skin, which then dries and cracks. But only to an unusually discriminating congregation can it be hinted that cleanliness is not an absolute law. It is a highly important one. Mankind has been afflicted with many diseases which could have been avoided by reasonable cleanliness.

**The itch mite.** Hahnemann, the founder of homeopathy, stated that seven-eighths of all chronic diseases were due to the itch. In the old dirty days many people must have had this. It is produced by a tiny mite which burrows into the skin. There is small chance of its becoming established in the skin of reasonably cleanly people. Many of our young men, however, have been scattered about the globe in recent years without the opportunity for gracious living that many enjoyed at home. Under these conditions the itch has increased. And when such a person comes home to his family, this family finds out that it is a community affair. These little mites and their eggs get into the bedding and clothing. The treatment is bothersome and uncomfortable, and, if any one member of the family fails to be freed, it is in vain.

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one. Almost every animal has its own pet lice. Different tribes of men have their own. The natives of Africa have dark lice. The Caucasians have white ones. We about here have three separate kinds, for lice are more cliquish than college fraternities were supposed to be. Pediculus capitis frequents the hair of the head; pediculus pubis stays about the external genitals; while pediculus corporis takes all the rest of the body for its domain. They all belong to the aristocracy with a tremendously impressive ancestry. Undoubtedly the Queen of Sheba had lice as did most monarchs until fairly recent times.

Whenever conditions over a long period of time make it difficult to wash fairly frequently and change clothes, lice are pretty apt to appear. All of us in Europe during the First World War knew that body lice were almost inseparable from soldiers. There was no more familiar sight than boys sitting about picking the cooties from their clothes. I never found any on myself, although the trench fever I contracted was proof positive that they had called on me; but I imagine that except for a little itching cooties are ordinarily not very bothersome.

Still I presume that nobody likes them but they do command respect. They have played a great part in the world's history. If the patient that they bite has typhus fever or some other bad diseases, the lice themselves become infected. Many of the unfortunate creatures die, but if they live to feed upon somebody else then the result is another sick person. Typhus has been the chief disease spread in this way. Hans Zinsser in his most interesting and instructive book, *Rats, Lice and History,* shows us how most of the great wars have been won or lost according to the amount of typhus or other disease in the respective armies. Yet though the generals have been exalted or degraded, the louse has been ignored. Here are some slightly abbreviated lines from Oliver Herford suggesting a different view of the relative importance of man and lice . . .

*If this little world tonight*
*Suddenly should fall through space,*
*Shriveling from off its face*
*In an instant every trace*
*Of the little crawling things;*
*Ants, philosophers and lice,*

Cattle, cockroaches and kings:
Who can say but at the same
Instant from some planet far
A child may watch us and exclaim,
"See the pretty shooting star."

**"Diseases blossoming out upon the skin."** Although the uninjured skin is germ-proof and it takes cutting instruments such as knives, needles and the boring tools of lice and itch mites, to penetrate it, still our minute enemies, bacteria and viruses, make many successful flank attacks on it. However they enter the body, they make plenty of trouble as they travel along, and in most cases the changes in the skin are the least important. Thus with spotted fever, as meningitis was formerly called, the infection of the brain is what raises havoc; and in scarlet fever, the effects on the heart and kidney can cause death. Fortunately, this disease has now become comparatively mild.

As the skin is wide open to observation, and nothing impresses us more than what we see, it is to be expected that a group of diseases with remarkable skin changes should be classified together. They were given the name exanthemata, a snappy word signifying "diseases blossoming out upon the skin." These were of great importance long ago, their victims often being isolated in pest houses. In my medical school days patients with skin diseases of this type were often put in separate hospitals, although we no longer called them pest houses. These diseases were all extremely contagious. I suppose that they are still just as contagious, but we know better now how to handle them. Smallpox is an example, once dreaded everywhere, now practically non-existent in the United States.

**Acne.** There is one disease of the skin which still blossoms out everywhere and is not considered with the dignity which it deserves for it does not make people sick; that is, except for their being sick at heart. This is acne. It unfortunately attacks most people during adolescence when naturally they want to be looking their best. Rarely is it any more than a nuisance, but the number of questions about it which have been addressed to me show that it is a big one.

I should not say much about it because we really know

almost nothing about it. I was thoroughly convinced that this was so when a few years ago our most prominent medical journal in its "Question and Answer" column took up five inches of fine type and big words to discuss the problems of acne. Almost everything that youngsters would like to do was forbidden, and almost every minor bodily difficulty which they could have was blamed for it. The best I can do for you is to warn you that it should be treated gently.

When acne is present, there is infection with pustules and inflammation in the layers of the skin. Irritation of inflamed areas is almost sure to stir up trouble. Don't squeeze or use a needle. Also avoid strong antiseptics, even if they come in soaps. Cleanse gently without scrubbing and do not clog the natural openings of the skin with such materials as powder and salves. You should refrain from spending your money on advertised cures. Finally, I should like to express my fears concerning the use of sex hormones. As acne usually occurs at just the time when there are striking sex changes ocurring in the body, it is only natural that people with more enthusiasm than judgment should rush to use these hormones, which are potent substances that should be utilized only under expert medical supervision, not otherwise.

The after-effects of acne, which are rough, thickened skin with pits and elevations, are now treated effectively by far from gentle methods. These may be likened to the smoothing of a board by sandpapering or planing, and they are so painful as to require anesthesia.

**Psoriasis.** Another mysterious and one of the commonest of skin diseases is psoriasis. It is probably not well known to the general public as it usually persists throughout the patient's life, so it is not brought forward as a subject of conversation. In fact, being rather disfiguring, it is kept secret as much as possible. It consists of scaly patches on the skin, the more common locations being the back of the arms, the front of the legs, and the body. Fortunately the face is frequently spared.

Psoriasis starts as minute spots which grow and merge into large areas, occasionally covering the whole back or even the whole body. Although the patient is usually symptom-free, being bothered only by the disfigurement and the untidiness of

the scales flaking off, nevertheless severe cases may feel run down and even quite sick. Fortunately the scaling has a tendency to clear up at times, especially in warm weather, but it will break out again as cold temperatures return.

The cause is unknown. No evidence has been found of bacteria associated with the eruption, and the disease is not contagious. Some of the other ailments of the skin may be confused with psoriasis and the treatment proper for them would be bad for this condition. Therefore it is important that a competent skin specialist make the diagnosis. Probably sooner or later all such cases are seen by specialists, for even the most ignorant or indifferent will not forever accept with equanimity such unpleasantness.

There have been many methods of treatment, some of which give good results. Medicines taken into the system have in general amounted to little. It is fortunate if they do no harm. Vitamins, of course, have been tried. Massive doses have generally been considered necessary by their users, and in such amounts they are not at all innocuous. Experiments with diet may seem to help or to coincide with improvement. Apparently there are no good rules for this.

External applications give the best means of relief. They have to be handled with care and according to the state of the disease. It would be useless here to give a list of the drugs used. Self-medication is dangerous either with drugs or ultra-violet light from lamps or sunlight. And the relief is temporary. Almost always there are bound to be recurrences. X-ray has been used, but in a chronic recurring trouble like this one it should be seldom resorted to, for cancer is a distinct danger where these rays are repeatedly used on unhealthy skin.

All authorities agree that there is no definite cure or permanent alleviant. I do not believe that any good physician, having treated a case of psoriasis, ever assures the patient that he will no longer have the disease. In fact, I believe that he will tell him that he must expect to have it return later. It fluctuates so much, occasionally disappearing for a time, that false hopes are bound to arise. Occasionally, but rarely, it has disappeared and not returned. Nobody knows why. Perhaps the period of remission has just happened to exceed the patient's life span.

**Athlete's foot.** In contrast to this rather discouraging report about psoriasis, where medicine has not yet found the answer, it is a pleasure to tell of a disease which used to be decidedly bothersome but which in the modern city today (I have it on the word of the dean of our dermatologists) hardly ever causes a visit to the skin specialist's office. This is athlete's foot, or epidermophytosis, a fungous growth that thrives on moist, warm skin. Practically always growing on the skin are some mold-like organisms such as cause wheat flour to spoil. As they grow best in moist, warm areas, they are usually found between the toes or in the groins where they have the familiar but not very polite name of jock-strap itch. Not only the young athlete in the boy's or girl's school often caught this; but any hot city dweller seeking relief on a crowded beach was likely to pick it up. There are effective powders and salves, available at the drugstores, to relieve these symptoms. Best of all, preventive hygienic methods at swimming pools and beaches now protect our feet from infection so that the swimmer or sunbather seldom needs to suffer from athlete's foot.

**Shingles.** In considering diseases of the skin it must be remembered that the skin is an open book, spread before our eyes. What we see is, if the change of metaphor may be pardoned, merely the surface manifestation of what is happening in the depths. Take the ridiculously named shingles. When it is dignified by its Latin name of herpes zoster, we are more ready to consider the great suffering that accompanies it, particularly prolonged in elderly persons. Yet this classical name means merely a girdle of blisters.

It is agreed now that it is an inflammation in a ganglion, or knot of nerve cells, from which nerve fibers extend to the skin. The blisters always follow along the skin where the fibers end. The pain may appear before the skin lesions, thereby making diagnosis difficult at first. It never kills, but it may make its victims resigned to death.

## The use of cosmetics

With all these skin troubles just described, certainly none of which add to the personal appearance of their owners (perhaps we might exclude here the delicate pink of an occasional

case of scarlet fever or the same lovely hue of a drug rash in a young woman), there is little wonder that tons of lotions, powders, and ointments are provided at dignified expense by the great cosmetic industry. Those who have suffered disfiguring disease are, of course, a small minority.

But, with the vast number of us who are certainly plain in appearance, hope springs eternal in the human breast and we are willing to make big financial sacrifices that the commercial cosmeticians may give us radiant beauty. Man, and also woman, constantly tries to improve on nature. This attempt is often not successful in conditions in the outside world, and it is often not a good idea when applied to the skin which is, paradoxically, both tough and sensitive.

It is fair to state that the prudent use of many cosmetics now available helps in attaining a well-groomed appearance which contributes to poise, self-assurance, and general happiness. Only occasionally do these cosmetics cause skin trouble, but their users should always bear in mind that this may occur. The law has stepped in and stopped the use of some dangerous, irritating substances sold in the past. You must remember, however, that there is hardly a substance which does not cause an allergy in some people. The difficulty is that the victims usually do not have their suspicions aroused, for they often use these substances a considerable time before the effects are noticed. Hair dyes, lipsticks, nail lacquers, and perfumes not infrequently do this.

Some time ago I saw colored photographs of young women with weeping eczema on the face and on the nape of the neck. It was hard for these girls to realize that the contact with their nail lacquer as they rearranged their hair and complexions could cause this sad effect. Another set of young ladies were out to produce the insidious effects on the male sex that the advertising pages guarantee are associated with their expensive perfumes. Unfortunately some of these found that they had rough, reddened, and chapped areas on the sides of the neck and on the arms where, I am told, they were wont to apply their seductive materials. Once suspicion is aroused, it is of course possible to determine the guilt by leaving off the cosmetic or even at times applying it in a different position.

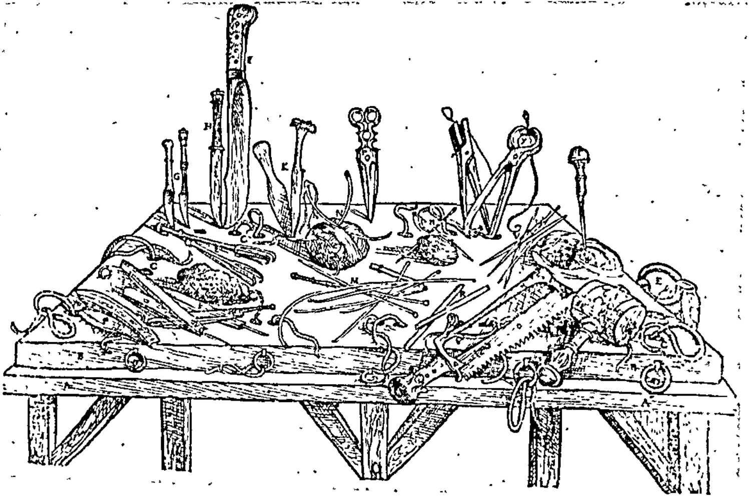
As the use of facial creams is practically universal now, the

makers of cosmetics are naturally developing the market to the limit. The real up-to-date thing is the estrogenic cream. Estrogens are the sex hormones that modern young women usually have in great abundance but which are supposed to decrease with advancing age. The skins you love to touch occur mostly in young women. The sellers of estrogens say that they slow up the aging process and cause wrinkles and other imperfections to disappear from the skin, that they keep the face young and the complexion beautiful. Well, these claims have been investigated carefully and the upshot is that these hormones do not amount to anything. The creams in which they are given sometimes soften up old skins a little, and young skins are not affected. Use your fatty creams for dry skin if you wish, but do not trifle with the hormones.

### *The skin continually renews itself*

Since the cells in the lower layers of the skin are continuously growing and then dying as they get nearer the surface, it follows as a matter of course that they must be got rid of. Only the other day a patient of mine who had his leg out of a cast for the first time in a number of weeks was surprised to find how much powdery skin he could rub off.

This rubbing off of the scales of skin rarely seems to bother people much except when it occurs on the scalp. Then it is called dandruff and it is evident that many people find it a great nuisance. Modern dermatologists apparently do not consider it dignified enough for their consideration. In general man's skin has not changed much in modern times, and so the book on diseases of the skin that I got in medical school forty odd years ago still serves me very well. It has several pages on dandruff. I have recently consulted two large up-to-date tomes on dermatology and they pay no attention to it except for those rare occasions when it is associated with severe infections. The original idea was that dandruff is an infection. I cannot find much evidence that infection here is really of much importance. My old book talks about seborrhea oleosa and seborrhea sicca. Apparently all this means is that in some cases a greasy skin rubs off and in other cases a dry one. I think the



The instruments of Vesalius for dissection of dead and living animals, shown on a plank for vivisection.

general public should be trusted to treat themselves accordingly.

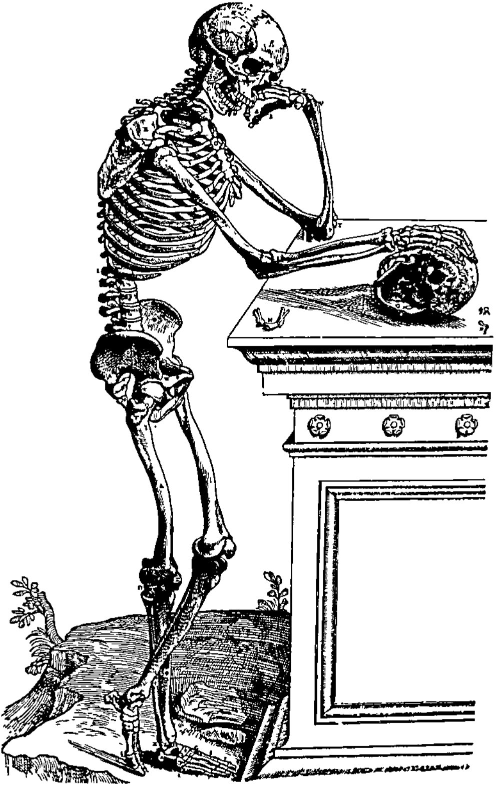
Without a constant renewal of the dermis and a rubbing off of the epidermis, the skin would become pretty battle-scarred. It can have rough times, as we have seen, attacked from without or within. This often causes most uncomfortable disfigurement to its smooth pristine beauty. Yet the live cells of our dermis are usually able to repair the damage so that our snug-fitting garment can continue its important duties: to protect, to eliminate waste, and to regulate heat.

With all of these many activities of the skin, is it any wonder that Dr. Walter in his book on the vertebrates speaks of the skin as a jack-of-all-trades? It is the biggest organ in the body. I believe that in a good-sized man there is about twenty-five square feet of surface. It has about two and a half million sweat glands. Despite all its varied activities, we keep it reasonably young by continually renewing it. Perhaps many of you who are familiar with the country know that snakes periodically "slough" off their old skin, appearing in a new one. We also get rid of ours, but we do it continuously. The average man of three score years and ten has shed forty-five pounds of skin in his lifetime.

## BONES AND MUSCLES

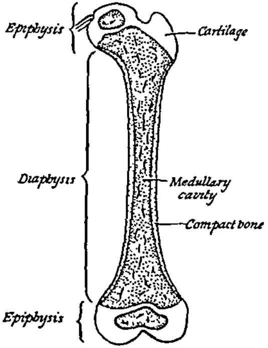
Dried bones are usually studied first by the beginner in anatomy for they are relatively pleasant things to handle and easily preserved. A classmate of mine at the Harvard Medical School, now a distinguished scientist devoting his life to the wetness in the body, owned a skeleton which, to the horror of his chambermaid, dangled over his pillow. No other parts of the dead body could be lived with so familiarly.

It might well be thought that mankind, at the very beginning of historic times, would have learned the anatomy of human bones, for the battlefields about "the cradle of civilization" were sprinkled with them and charnel houses furnished an inexhaustible supply. Really to study them, however, requires a knowledge of musculature, and human dissections were generally forbidden. Besides, for over a thousand years after



A skeletal Hamlet soliloquizing beside the tomb upon some poor Yorick. A delineation of the bones of the human body, viewed from the side. (*J. B. de C. M. Saunders & C. D. O'Malley,* Vesalius' Illustrations From His Works, *Plate 22. World Publishing Co., 2nd Printing, 1950. Reproduced by permission of N. Y. Academy of Medicine.*)

Christ, the words of Galen on medical and associated matters were accepted practically without question, and Galen, like all men, was fallible. Then, with the revival of other learnings in the Renaissance, came a number of brilliant anatomists, and outstanding was Andreas Vesalius, born in Brussels in 1514. He lived to be fifty, but his anatomical work was pretty well finished in his early thirties. Henry Gray, whose book to English-speaking people is practically synonymous with anatomy, died in his early thirties. Do we really need that extension of life which we are now getting?




Parts of a young bone, as shown by a section of a femur. (*After J. C. B. Grant,* Method of Anatomy, *p. 6. Baltimore: Williams & Wilkins Co., 1952.*)

Vesalius moved about a good deal but his most famous work was done at the Medical School of Padua which was then several centuries old and is still going strong. The illustrations are such excellent works of art that they have been attributed at times to Michaelangelo and Titian. The skeletons as Vesalius

shows them remind us that no matter how lifeless bone may appear it is living growing tissue in the body. Add to this that throughout life it is busily engaged in making other tissue. The blood cells are formed in the marrow of bones. When certain blood diseases are suspected, we cut a little disk out of the easily accessible breastbone and under the microscope examine the marrow to see how the cells are forming.

## *The bones*

In the first stages of a baby's development there is no bone. In its place is cartilage, or gristle. The bone begins to form in the cartilage at growth centers according to a definite scheme. Long bones, as for instance the thigh bone and the shinbone (femur and tibia), consist at this stage of the shaft which is called the diaphysis and a growing center at each end called an epiphysis. These epiphyses grow so much on schedule that the age of a child may be pretty accurately determined by X-ray.

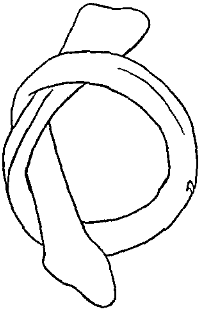
Yet bone does not grow simply by adding on. It is continuously being reconstructed. Cells called osteoclasts tear down bone and osteoblasts rebuild it with new. As one grows old and uses the bones less, the osteoclasts are apt to get the upper hand. This is best shown in the old man's chin after the loss of his teeth when much of the bone of the jaw is absorbed, causing an upward curve.

> But now his nose is thin
> And it rests upon his chin
> Like a staff.

There are channels for blood and much soft tissue in the hard bone which is mostly calcium, as is an oyster shell. If you burn a bone, its shape remains but it becomes brittle like an egg shell. If you immerse it in acid, the calcium and other minerals disappear and it is now much like a puppy's rubber bone.

The finished product is an excellent piece of architecture and engineering. One practically never sees an absolutely straight bone. It is curved to fit its function. It is enlarged where a

bearing surface is needed, or rounded to fit into another bone at a joint. It has ridges, knobs, and rough places for the attachment of ligaments and tendons. It is dense where strength is needed and spongy where weight must be saved. To the knowing eye an old bone is a wonderful object.



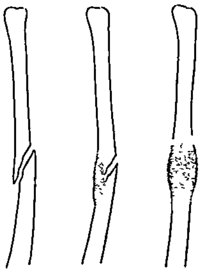
Bones have an organic framework of fibrous tissues and cells, among which inorganic salts, notably a calcium compound, are deposited. By submerging a bone in a mineral acid, the salts are removed. Above, a decalcified fibula can be tied in a knot. (*After J. C. B. Grant,* Method of Anatomy, *p. 1. Baltimore: Williams & Wilkins Co., 1952.*)

One skilled in osteology can tell a female skeleton from a male. The female is usually smaller and the bones are lighter. The bony thorax, or chest, is narrower. The shoulders are narrow and the hips broad. This latter feature is so because the one chief function of the sex is to bear the future members of the race, and the broad pelvis makes room for the child. Before the days of frequent Caesarian section we said that the angle of the pelvic bones in front was widened in the female as all humanity had to pass under the arch. Incidentally, the broad hips result in the thigh bones being well apart at the top and coming together below. Hence all women are knock-kneed. It was said of a drama critic that he knocked everything in the show except the chorus girls' knees and God had anticipated him there.

He who would take care of broken bones should have a knowledge of anatomy, physiology, and likewise mechanical engineering, not to mention old-fashioned plumbing. Nature heals here much as a plumber of the last century "wiped a joint" in a lead pipe. With the

two ends of bone together, "callus" or new bone is spread around the juncture as molten lead was allowed to cool around the pipe. If the ends touch each other firmly and evenly, the less callus is necessary and the quicker the union occurs. When the extra callus is later absorbed, a perfect union may result and no trace of the injury remain.

But physiology takes precedence over plumbing here. If the ends are displaced to the side so that they barely meet, nature is still able to hold them together with callus and later smooth off the corners. Right here the surgeon must not forget mechanical engineering. The bones are so designed that the muscles and tendons pull in just the right lines of force. If the ends meet squarely but are much angulated at the site of fracture, then the muscles have to pull in the wrong direction and do not work well, thus disabling the victim.



Knitting of bone (femur), showing formation of callus over break. This callus is later absorbed. (*After L. Böhler,* Treatment of Fractures, *p. 96. Translated by Groves, W. Wood & Co., 1935.*)

Possibly the most striking example occurs with a Colles fracture, which is a break in the radius, one of the two bones of the forearm, just above the wrist joint. If the lower fragment is left tipping backwards only ten degrees, the result may be a poor wrist thereafter.

## *The joints*

There are places as in the skull where the bones are dovetailed together, but generally between the two adjacent bones there is a joint which allows motion. At the joints the bones do not come in direct contact with each other. Their surfaces are cushioned with yielding cartilage and lubricated with fluid

contained in a tight sac. This fluid is called synovial fluid. It is a great protection and, when a joint is injured, the fluid is increased in amount. The patient with water on the knee, misunderstanding the beneficent ways of nature, is likely to be unappreciative.

One finds this fluid in places other than joints. The tendons run in sheaths thus lubricated. Where a tendon runs over a bone, there is a little sac of fluid called a bursa. Who of you having arrived at middle age has not had bursitis of the shoulder?

In the spine each vertebra lies flat on the one beneath with a thin disk of cartilage between, and there is little motion. At the shoulder the humerus, or arm bone, is ball shaped at the end and fits into a socket on the shoulder blade, thus making almost a universal joint that allows free motion in every direction. Fancy a big league pitcher without this universal joint!

The hip joint is also a ball and socket, but the ball is on a long neck coming in from the side so most of the free motion is forward and back. At the knee the whole weight of the body has to be borne on the flat top of the tibia, or shinbone. Motion has to be sacrificed to stability, so all the motion we have is forward and back. I would not dare to say, offhand how many joints there are in the body; each wrist for instance, has eight bones and thirty-four joints.

Each joint of the body is held in place by various ligaments and there are usually many muscles going by each joint that assist in controlling it. What a simple job is that of an orchestra leader or a football coach compared with the coordination of the many joints and muscles you have to direct every time you move.

Arthritis. The joints cause a lot of trouble, for life's activities often result in a great strain being put upon them. The ligaments which hold the bones together on either side are the toughest material in the body. They are the gristle which you sometimes cannot cut or eat when you are feasting on meat. Nevertheless the leverage which a heavy twisting human body may put upon them will tear them, and produce the familiar swelling with fluid in both the tissues and the joint space.

These acute injuries may be recovered from fairly promptly, but the chronic joint troubles are among life's greatest bugbears.

Arthritis means inflammation of a joint. However, there is often more than the joint involved, the bone and soft tissues nearby being inflamed or destroyed. Rheumatism is the word often used for this condition and it is a handy one, being inexact and comprehensive and suggesting the patient's symptoms.

Evidence of this disease is found in all old bones, those of dinosaurs, ape men, old Egyptians, and so on down to your next-door neighbor. They all have had arthritis if they haven't died very young. This disease does not kill but it cripples, which makes the problem harder. The figures compiled by insurance companies show that it produces twice as much sickness as tuberculosis, three times as much as heart and blood vessel disease, and ten times as much as cancer.

The different types of arthritis can be divided into two groups. In the first the cause is known; in the second it is not. First we have arthritis following an injury, such as baseball finger or sprained ankle. Chronic injury may also cause chronic arthritis. If a person has a badly set fracture of the leg, continual bearing of the weight in the wrong position may ultimately result in arthritis of the knee joint. Also such diseases as tuberculosis or gonorrhea cause arthritis. The outstanding example is gout. This has had great prominence in the past. Every gentleman of social standing in the eighteenth century expected to have his big toe swollen and excruciatingly painful at times. He drank great quantities of port and fermented liquors and ate astonishing quantities of rich foods. This diet had something to do with uric acid in the blood, and often urates formed on the fingers or ears like pieces of chalk which could be picked off.

The second type of arthritis, of unknown cause, comprises rheumatic fever, degenerative or hypertrophic arthritis, and rheumatoid arthritis. Rheumatic fever does not do permanent injury to the joints. Degenerative arthritis on the whole is not so bad, which is fortunate, for sooner or later almost everybody gets it and there is no predicting how soon or late. It piles up

bone around a joint; gnarled fingers are common. If you have reached middle age, X-ray will probably show some in the spine. The inclination of people to fuss about aches and pains largely determines the severity of the disease. Keep your weight down and use heat and massage for comfort.

Last but worst in this group is rheumatoid arthritis. It makes its victims generally sick and can be crippling to the point of helplessness. Proper care of the patient, such as rest, heat, and therapy, may help a great deal. The use of ACTH, cortisone and the like, although not the miracles advertised at first, is yet of much value and offers great hope for the future. They will be described in the chapter on hormones.

## *The Muscles*

Thus the bones and the ligaments make up the framework of the body. The muscles support it and move it. Most of you undoubtedly think of the muscles as made for motion: they are, but also for support. You stand waiting for an elevator to take you down two flights of stairs or, if you are a youngster, you try to thumb a ride for a few blocks. You think that you are saving energy but you are often fooling yourself. Whenever you are upright, your muscles are working to keep you there. If they quit, you fall in a heap. It is hard work because they cannot relax. Constant tension on muscles is always extremely tiring; in tetanus or lockjaw, for example, the muscles do not relax and the suffering is great. Of course the strain on your muscles at the elevator is not like that of lockjaw, but just the same they are not loafing.

All living tissue has contractility, especially the muscles, for they do their work by the power of contraction. When they relax, they simply go back to their original condition. The muscle cell is long, narrow, and spindle shaped; and, as the contraction occurs, there is naturally a relatively large amount of motion at the ends. The cells are gathered in strands and bound together by tougher tissue. Then these strands are bound together into bigger strands. It is all much like the make-up of rope.

Muscles do their work by pulling; they never push. Op-

Muscles from Vesalius. (*J. B. de C. M. Saunders & C. D. O'Malley,* Vesalius' Illustrations From His Works, *Plate 25. World Publishing Co., 2nd Printing, 1950. Reproduced by permission of N. Y. Academy of Medicine.*)

posing muscles produce the motion in the opposite direction. The biceps flexes the elbow; the triceps on the opposite sides of the bones extends it. The big quadriceps muscle on the front of the thigh extends the knee; the hamstrings in back flex it.

But once a muscle has finished its pulling, it does not let go completely. It keeps a gentle restraining effect on its opponent. Otherwise our motions would be exceedingly jerky. Your triceps extend your elbow for a cup of coffee. Did they completely relax once you had grasped the cup, your biceps would snap back like a rubber band and the contents of the cup presumably would go over your shoulder. The physiology that I have given you above is simple, but I think that it approximates the truth about as closely as physiology can be presented to the non-scientific person.

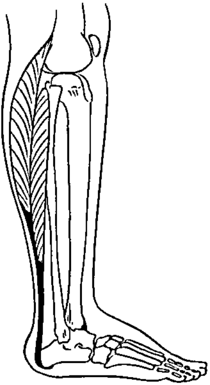
Most of the muscles are spindle shaped, tapering at the ends. The tough tissue which has been described as binding the strands together forms at the ends into heavy tendons. Although, as you know, the muscle is soft and each strand would stand little pulling, when the minute contraction of each cell is multiplied by millions the resulting power is something.

The tendon ends are practically welded into the bones. The end attached to the bone which it does not move is called the origin. The other end where the bone moves a great deal is the insertion. The example best known to all of you is the calf of the leg with the origin on the bones at the knee and the long tendo Achilles, or heel tendon, running down some six inches to its insertion on the os calsis. You people must be lenient with us if we occasionally use our own favorite terms. Never have I heard a professional reference to a broken heel bone; it was always a fractured os calsis.

The tendo Achilles pulls the heel up, thereby causing the ankle to bend and the toe to go down. Feel it just above the heel, so that you may realize how heavy and powerful it is and how it gradually merges into the muscles at the bulge of the calf. How convenient for the grip of the mother of Achilles as she picked him up to dip him in the Styx.

*E pluribus unum*, which is engraved on our United States

currency, is surely the motto of our muscles. I have told just above how the myriad cells of a muscle each adds its mite to form the might of a tendon. At least two muscles in the calf pull on the Achilles tendon; and the triceps on the back of the arm starts as three, merging into one. In fact, no one muscle ever works alone; always some others are either pulling with it or steadying it. Watch an athlete striving to win a hundred-yard dash. Every muscle in his body is cooperating, even to the muscles of expression in his face and even the muscles connected with the alimentary canal may take part.



The tendon of Achilles, in black, showing how the work which muscles do may be applied at a point some distance from the muscle itself. (*After W. Pickles. Walter & Sayles,* Biology of the Vertebrates, 3rd Ed., *p. 648. New York: Macmillan, 1949. Reprinted by permission.*)

As an illustration of the combined power of the soft muscle cells, I can tell you that they have been known to tear the great Achilles tendon in half. A fractured patella, or kneecap, is not uncommon and rarely does it result from a blow but from a spasmodic pull by the muscles on the front of the thigh. One of the last cases I handled was that of a delicate little woman of sixty-eight who missed her step from the curb to the street, and whose muscles gave such a jerk that she broke her kneecap.

These spindle-shaped muscles of the limbs are so designed that their bulk may be up out of the way, only slender tendons going to the hands and feet where trimness and unobstructed motion are desired. At the thighs, buttocks, and back, strength

and disposition of weight close to the center of gravity are important and the muscles become more massive and ponderous at these parts. Also they are fused together so that it is difficult to say where one leaves off and another begins. But the nerve supply will tell the anatomist because as Dr. Herbert E. Walter so well expresses it: "A nerve once assigned to do duty with a muscle follows it through all its vicissitudes, just as a faithful dog, trotting behind its master, always serves to identify him, regardless of the different costumes or disguises which the master assumes."

A striking example of this fusion is the diaphragm, the great, flat, dome-shaped muscle which separates the abdomen from the chest cavity, and with which we do our best breathing, "belly breathing." The diaphragm originates in the neck; the phrenic nerve which controls it comes off from the spine not far from the skull and runs through the chest cavity. Some years ago it was customary to rest a tuberculous lung by temporarily paralyzing the diaphragm on that side. This was done by making a little incision in the neck just above the collarbone, picking up the nerve and crushing it. Later the injured nerve fibers would grow again and the diaphragm would become active.

Muscles under normal conditions always have some tonus. This means that they are never completely flabby but are kept on a slight amount of tension. Therefore they are always guarding and exerting some control over that part of the body they govern and are on the *qui vive* to move it if necessary. This tonus is bad, however, if exaggerated. A continuous tightening of the muscles is very exhausting. Athletes in the best of trim can make their muscles hard as iron, they also have more than average ability to relax them. Muscles at their highest efficiency also have to be handled with the greatest care. My poor arm now can throw a ball as well on the first try as on the tenth or twentieth; none of them good. A big league pitcher starts with a very short throw and takes fifteen minutes to warm up.

**Foot strain.** In considering the whole framework of the body and the apparatus for giving it motion, I imagine many moderns

feel that the foot plays a minor part. But an authoritative article which I have just read says that the highly mechanized army of today depends increasingly on the state of the feet. It also says that the large number of serious foot troubles in the young men entering the service is shocking.

We had best look with a critical eye, however, on what takes place in the armed forces. In World War I, a certain young man was rejected by the armed forces because of flat feet; the year after the war ended he won the Boston Athletic Association Marathon, running twenty-six miles, three hundred and eighty five yards, over hard pavements. This merely points up the fact that too much indiscriminate attention has been paid to the height of the arch under the center of the foot.

The foot is the very basis of human anatomy. Even in this mechanized age most people have to be on their feet a good deal. The feet support us, balance us, and start most of our motions. They should have intelligent care from the moment of birth. A famous orthopedic surgeon said that the care of club foot should begin while awaiting the delivery of the placenta. Actually very few children are born with bad feet; rather, the great majority start with good feet and then so-called civilized people proceed to ruin them. I doubt if many American Indians before their association with the whites developed flat feet or if the African savages do.

The foot was originally intended to go bare so that it could take its normal position and get normal exercise. Feet have made trouble principally because shoes interfere with these two conditions. No other part of the body has been habitually encased in a rigid framework, preventing free motion, and, what is more, absolutely forcing it into the wrong positions. For centuries the pointed-toe shoe was considered, if not the acme of beauty, at least of fashion. When Elizabeth Hawes said that fashion is spinach, she slighted the attributes of a very potent drug. Rarely does one see an adult foot that corresponds to what a textbook on the anatomy of the foot considers normal: a turning of the big toe to the outer side is almost universal. When this is carried to an extreme, a bunion is likely to develop and may be disabling. Wear proper shoes

during the growing age, exercise the feet, and be careful about much wearing of poorly shaped shoes at any time.

These observations should not be construed as a plea for dressy young women to attend their social functions in "common sense" shoes—straight inner sides, square toes, low heels. It is not to be expected that dressy women will go to dressy parties without dressy shoes. If they will wear sensible shoes most of the time, they may indulge in a little foolishness at intervals. A little nonsense now and then is relished by the wisest men. And women.

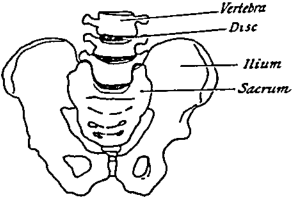
In this mechanical age it should be unnecessary to point out that when any machinery is "out of line" there is resulting trouble. A misshapen foot puts extra strain on the ligaments and muscles that support it. Add to this that the free movement of the muscles is interfered with, and the trouble is compounded. It is not the lowness of the arch, the "flat foot," that is the cause of the difficulty. Negroes are notoriously flat footed and yet, as we all know, they are often the finest of athletes. But once the ligaments have stretched, a chronic distressful condition occurs that is difficult to restore to normal. A better term than flat feet is "foot strain," as it is the resulting strain upon the muscles attempting to compensate which causes the symptoms. This strain may be felt all the way from the foot to the back. One hint: if you are carrying extra weight, you are not giving your feet a fair chance.

The lame back. An observing friend of mine divided men into two classes: those who fuss about their lame backs and those who ignore them. For all men have them unless they die young. The lame back has always been a prolific source of income, much of it received with clear consciences, for its obscurity and, presumably, many different causes have naturally led to many treatments. All the cults have had their own ways of treating it and often successfully, for nearly all of us have had our periods of remission, and the psychic factor is important.

Early in this century earnest and industrious gynecologists provided well for their families by doing "suspensions" on women with aching backs and tipped-back uteri. There are

still lots of tipped uteri and lame female backs, but we are now pretty sceptical of the cause and effect. Right now I am thinking of one charming young woman, with a retroverted uterus and five or six children, whose dynamic life is still untroubled by low back pain.

Meanwhile, in the male sex, the sacroliac joints were usually held responsible for lame backs. One did not have to be well informed medically to tell one's friends glibly that one had a "sacroiliac." Probably most of you know that the lowest vertebra rests on a heavy wedge-shaped bone called the sacrum.



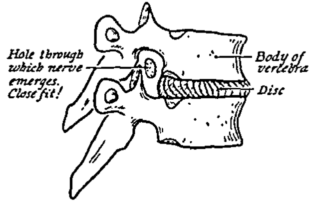

Sacroiliac joint.

This, with its narrow portion down, fits, like the keystone of an arch, between the right and left ilia. On the surfaces between the bones there is cartilage as in a joint. There is little if any space in these joints and as little motion. However, they were blamed for much grief and finally a distinguished orthopedic surgeon developed an operation to fuse the joints. It is outmoded now.

A score or so of years ago it was shown that the disks of cartilage which lie between the vertebrae and act as shock absorbers could when ruptured cause severe back pain. They bulge out into the spinal canal and, as space is limited, they press on nerves. This may happen in the neck but it is far more common in the lower back where the five large lumbar vertebrae are supporting a lot of weight and are subject to severe strains. Since this has been understood, great numbers

of ruptured disks have been recognized and operated upon. The methods of diagnosis have been made more accurate and the operation made much less elaborate. At the same time it has been shown that many cases, possibly most of them, do *not require operation.*

This episode demonstrates what we believe is the necessarily slow painstaking development of good medicine. About the turn of the century, Theodor Kocher, a great European surgeon, reported a case where the vertebrae had squeezed together and ruptured a disk which had bulged into the canal. But the man had fallen a hundred feet and died within a few




Two vertebrae with disk between, showing where nerve emerges. (*After J. C. B. Grant,* Method of Anatomy, *p. 12. Baltimore: Williams & Wilkins Co., 1952.*)

hours. No surgical significance was attached to this. But the case was recorded. Years later, Dr. Walter E. Dandy, of Johns Hopkins, found cartilage sticking into the spinal canals of patients who had sciatica. In 1932 Dr. Jason Mixter, of Boston, operated on a patient with sciatica who had had an accident followed by pain in his lower back. Dr. Mixter and Dr. Joseph S. Barr recognized that the material which was projecting into the spinal canal was cartilage and they concluded that the patient had a ruptured disk. By the next year they were able to make the diagnosis, operate, and confirm it. And at the same time a doctor in France had arrived at the same conclusions.

The framework and moving parts of the human body are designed on mechanical principles, although far more elabo-

rately so than any man-made structures such as an automobile engine or a cantilever bridge. They also are affected by the physiology as well as the pathology, which means that they have to work whether the tissues are healthy or diseased. The wonder is that they do not more often go to pieces altogether but just function poorly and, rather than creaking and rattling badly, merely send word to the brain of their worn parts and need of adjustment.

Also in considering low back pain one must remember that the place where discomfort is felt on many occasions is not the chief seat of the trouble. Indigestion may show itself as headache; a disturbance of the middle ear may result in vomiting. A breaking down of the arch of the foot or a badly set fracture of the leg frequently produces backache.

If the broken bone of the leg is set at a wrong angle, then the thigh bone does not rest properly on it. Also the muscles of the leg which are attached to the thigh bone do not pull in the direction that they should. So the mechanics are wrong clear up to the back. The back muscles and ligaments have to handle the whole weight of the body from the waist up. With the little leverage that they have and the rather insecure balance of the body upon the pelvis, which is the great girdle of bone to which the thighs are attached, they have a big job even when everything is normal. Put things out of plumb and their task is really tough.

But one does not have to have fallen arches, broken bones and such catastrophic happenings to develop backache. Nature rarely if ever makes a perfect piece of work in building us. It is common knowledge now that the two sides of one's face are not perfect twins. No more so are our lower extremities (legs to you) or, in technical anatomical terms, the combination of thighs and legs. (I seem to remember from my medical student days that the newly arrived Yiddish-speaking immigrants called the entire limb from the hip to the ground the "*fuss*," or foot.)

Careful measurements would probably show that your two legs are unequal in length. Most people compensate for this discrepancy with little trouble. An orthopedic friend of mine has told me of numerous patients of his who never got com-

fortable backs until he took measures to compensate for the unequal length of their "legs."

In fact the lower back is one of the most vulnerable parts of the body. Fortunately the overwhelming proportion of afflictions to it tests our philosophy and equanimity but does not endanger us. When, as and if you get lumbago, it might be worth while to have a good look over, and if it proves to be just "misery," try to be one of the group who grins and bears it. Lots of your friends are doing the same unbeknownst to you. And don't take kidney pills. Aspirin is cheaper and better. *The kidneys are nestled in the small of your back, but, when they get diseased, they may cause you almost every kind of trouble except a backache.*

The one chief cause for backache is man's decision to stand upright on two limbs. It may be difficult to determine with accuracy whether four-legged animals suffer much from this affliction, but I have seen no reason to suppose that they do. Few of us spend much more than a third of our time lying down, and when we are standing or even sitting, there is almost continuous strain on the muscles of our lower back.

Human beings are the only mammals that really stand up straight. Of course, some of the big apes make a pretense of doing so, but certainly none of them has achieved the human ideal — heels together, head up, shoulders back, chest out, and belly sucked in. Many persons in attempting this posture remind one of Dr. Johnson's description of preaching women and dogs walking on their hind legs: "It is not well done. The wonder is that it can be done at all."

This erect attitude has made it difficult for the circulation in man's legs. Hence dilated veins, stagnation of the blood within, and the tissues round about swollen with fluid; changes in the arteries, and many resulting troubles in the tissues. The muscles and tendons have a tough job with all the weight of the body to handle instead of the half which the quadrupeds have on each pair of legs. Then higher up, the balancing puts great strain on the bones, muscles, and tendons.

Inside the abdomen, gravity and the erect position combine to make more trouble for us. Any or all of the abdominal organs may sag down. This is known as visceroptosis, or drop-

ping of the guts. A few swallows of barium and an X-ray examination of a thin, narrow person may sometimes show a most remarkable displacement downward of the stomach and intestines. This leads to one of the few arguments I know of for accumulating fat. As people plump up, they often overcome their visceroptosis.

There is one trouble in which the value of the horizontal rather than the vertical position has been often demonstrated, as is well known to many physicians. That is diarrhea. Many diarrhea mixtures have been used; nearly all of them, I think, have some opium in them which quiets the bowels. They also frequently contain some chalk-like material which, I believe, is supposed to coat the bowels. Abstinence from food combined with the horizontal position for a prolonged period is a simpler treatment but effective.

Now we have Dr. Richard H. Overholt telling us in the *Journal of the American Medical Association* that "septic bronchiectasis (pus in the small air passages of the lungs. Ed.) is another penalty imposed on modern man for his evolutionary assumption of an erect position." The infected secretions do not travel uphill freely from the lower part of the lung. Standing the patient practically on his head is a well recognized treatment.

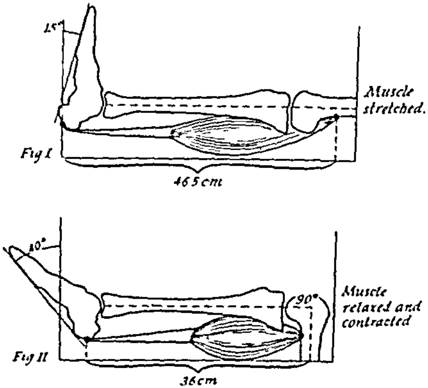
We have now arrived at the head and my friend the rhinologist (he treats your nose) continues the sad tale by informing me that man is peculiarly subject to trouble in his sinuses because they do not drain well as he stands erect. We have not much data as to relative positions above the nose, but how often does one see a quadruped with a bald head?

We must retain a reasonableness in all things; not go to extremes as we so often do. But a moderate amount of lounging is good for most of us. (People with sick hearts and difficulty in breathing may be exceptions.) More time in the horizontal position is a common prescription. It may well be used before the onset of illness.

**Posture.** Posture has long been thought of in terms of standing and sitting and correct posture as the erect position assumed when one is under inspection, but posture should really be considered as the sum total of the positions and

movements of the body throughout the day and throughout life. The above is the opinion of an orthopedic surgeon who leads an active outdoor life.

Good posture changes with age. The very young child is more like a four-legged animal than a man. As the child gets




Two diagrams of foot, lower leg and knee joint demonstrating abolition of muscle tension by position of joints. Fig. 1. Foot bent upward toward knee. Knee joint straight. Posterior muscle stretched to 46.5 cm. Fig. 2. Toe of foot down as in toe-dancing. Knee joint at right angle. Posterior muscle contracted to 36 cm. (*After L. Böhler*, Treatment of Fractures, p. 3 *Translated by Groves*. W. Wood & Co.)

moving about, he is potbellied and sway-backed—that is, like an old horse with a sagging back. But gradually, as he approaches manhood, the belly becomes less and less prominent and the curve of the back lessens.

In the past the ideal standing posture held up to us was that of the soldier on inspection: the chest expanded, the shoulders

thrown back, the toes turned out. This tense strained position is uncomfortable and inefficient. Who has ever seen an athlete perform efficiently with the toes turned out? The big toe is the part of the foot which does the work.

The argument for chairs designed for proper posture is based on the assumption that the occupants will conform their positions to the shape of the chairs, or vice versa. Children in their formative years are squirming organisms. They will not fit any shape of chair for long. Cats, the most efficient of athletes, always take loose slouchy attitudes when resting. The best quality of a chair would seem to be its comfortableness. It is safe to say that any posture taken temporarily while at rest is unimportant. It is only habitual bad posture which is harmful.

As the muscles are the only factor of posture controllable by the individual, exercises are the principal treatment. Sports are the pleasantest forms of exercise, and to be efficient at these it is necessary to apply the principles of posture in motion. For any of the muscles, the restful position, of course, is relaxation. But each muscle has its opponent. When you bend a joint as far as possible, you stretch the muscle on the other side. A position in-between rests both muscles. From this position each muscle is ready to do its work quickly and efficiently. Hence you see that when a person starts to rise from a chair, climb a ladder, run, walk, box or do any other active motion, his arms, legs, back and in general all his joints are somewhat bent and relaxed and thus ready for motion in any direction.

Proper attire helps this moving posture. The high collars of the old days are gone and the neck can now bend. Tight heavy clothing interferes with rhythmic movement. Thomson in *The Castle of Indolence* says:

> O fair undress, best dress! it checks no vein,
> But every flowing limb in pleasure drowns,
> And heightens ease with grace.

A reading of the poem will show that there was no intention to have the guests in the altogether but simply in loose comfortable clothing.

To sum up: Don't expect your young child to have the posture of a man. If he grows up with *a tendency to round* shoulders and caved-in chest, give him setting-up exercises in loose clothing and remember that the moving posture is the *important one, not that standing at attention for inspection.*

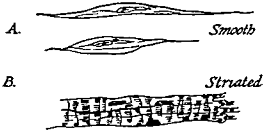
Not only does proper posture in motion give us ease and conserve our strength but it is necessary for good balance. The other day I watched a lovely year-old child playing about. Seizing a piece of furniture, she would pull herself to a standing position and remain thus erect *apparently until bored* but not tired. Yet she did not walk. Why not, when she had plenty of strength and often wanted to get to another place? It is because the act of *balancing is exceedingly complicated,* requiring the teamwork of brain, eye, ear, muscles, nerves, and some remarkable sensations called "proprioceptive." This *sounds tough* but the *word simply* has the *meanings* of "*proprietor*" and "accept." The brain is just taking sensations from its own body.

This *is* how it works. *You are standing upright but start to* topple to the right. Instantly sensations in your muscles, joints, and skin telephone to your brain: "Get busy, he is falling to the right." If *you are a tightrope walker, your brain in about a* millionth of a second has told your muscles to pull you to the left. The muscles get in the game quickly and some of these same sensations tell them exactly when they have done enough and not too much.

The physical laws of stability are pretty well ignored in the human body. The big drug firms are nice people so I am sure that one of the largest of them will not object when I quote a paragraph from one of its articles: "Take a flexible, somewhat rubbery, oblong, irregularly shaped object weighing in the neighborhood of one hundred and fifty pounds and measuring something under six feet high, with a center of gravity two-thirds of the way up. Put this object in motion and try then to balance it on a couple of bearing surfaces each no larger than twenty square inches. Chances are that it will topple over and crash." The writer is describing a predicament that comes home forcibly in the later years of life when these millionth-of-a-second reactions have gone forever. Of course, people who

may be classed as normal vary greatly in the delicacy of their balance. Otherwise circus acrobats would be out of jobs.

**Learn to use your muscles.** The type of muscles discussed in this chapter are called striated, because of their appearance under the microscope; and voluntary, because of the fact that they will respond to our desires. (The other two types of muscles are cardiac, or heart; and smooth, or involuntary. The heart has muscle unlike any other in the body. In the walls of intestines, blood vessels, and innumerable other places, are found the smooth or involuntary muscles, over which we have absolutely no control.) We can command our big muscles and they usually obey, but not always; and they often work on their




Types of muscle cells. (*After H. E. Walter,* Biology of the Vertebrates, *p. 134. New York: Macmillan, 1939.*)

own. You can stop your muscles of respiration, but not for long, and they keep up their motion throughout life with usually no attention from you. Also you would be a poor ball player if you thought out all your motions. Quick skillful motions are automatic.

Striated muscle tissue is "flesh," and in man it constitutes approximately 50 per cent of the weight of the entire body. If you wish to see how the fibers appear, look at a piece of cooked corned beef that has not been cut across, but has been teased out.

Despite all the modern gadgets and labor-saving devices, practically all of us have to use our muscles. It is important to understand how to use them in an efficient manner. Muscles do their work by contracting; that is, by shortening. If a muscle shortens quickly, it has to use more energy to move a cer-

tain load. If it shortens slowly, the time in which it is expending energy is increased. For continued, efficient work the trick is to learn the happy mean.

A few people see an illustration of this trick in the performance of their automobiles. Every engine has a definite speed at which it works best. Below this it does not move smoothly. Above this, resistance builds up with wasting of fuel. Of course with muscles or motors it does not follow that this ideal speed is best for practical purposes. Time is valuable as well as energy. I am not offering this as an excuse for reckless drivers in city streets. Life, limb, and auto bodies are also valuable.

It may be a decided advantage for muscles to move slowly. They have two chief tasks: to make motion and to hold position, and the same muscles may have to take on both jobs . As our physiologist friend says: "It might be very nice if we could move our arms a hundred times more quickly; but not if the consequence was that we could not hold them out horizontally for more than a second."

Of course, what muscles can do depends on many factors: their size, their manner of construction, and the material of which they are composed are the more important ones. Their normal function varies incredibly. Thus it has been said that the wing muscles of a gnat (insects so small that the Indians called them no-see-ums) can perform a motion in a thousandth of a second; a hummingbird in a hundredth; and the swimming muscle of a whale in a full second.

Not only the muscles themselves count, but also the skill with which they are handled. Consider the whip action with which a big league pitcher accumulates speed. As his leg, lifted high in the air, comes down, it speeds the body forward; the shoulder muscles speed the arm; the muscles across the elbow accumulate; the snap of the wrist smoothly adds on, and finally the finger tips are traveling at the speed with which the ball leaves. This has been estimated at over 120 feet a second — a ninth of the velocity of sound.

A physiologist who has read the Book of Judges tells how Gideon selected three hundred men from his army of thirty-two thousand and conquered the Midianites. He sent home

twenty-two thousand who were "fearful and afraid." Then he dismissed all who bent on their knees to drink, keeping those who lapped water from their palms. The ways of those primitive people were strange. I would have picked those limber enough to have bent their knees to quaff liberally from the stream.

Our scientist has a similar test for a modern army in a modern building. He would first have got rid of the twenty-two thousand fearful and afraid of exercise, who would have waited for the elevator to take them down two floors. The remainder he would have marched down into a subway, and have chosen the three hundred who ran up the escalator, "improvident of energy and impatient of delay."

Most people believe that physical fitness helps in resistance to infectious disease. There is practically no good evidence to this effect. Before the days of antibiotics the finest athletes might succumb to pneumonia as promptly as any weak-looking little specimen.

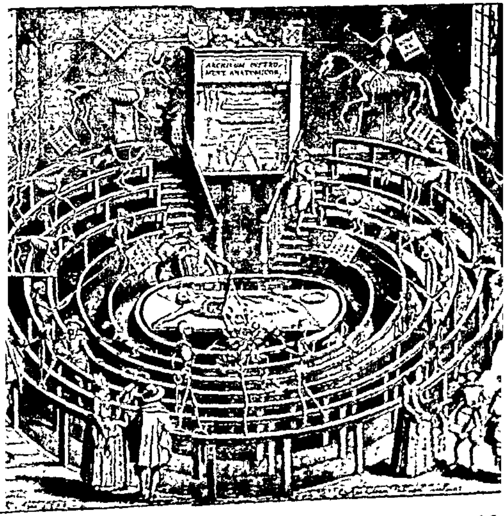
In a state of nature the demand for physical exercise is satisfied as instinctively as the demands imposed by hunger, thirst, and cold. Perhaps the best demonstration that you can get in so-called civilized life is that of school children at play. They are young animals. Observe how after a short period of imposed inactivity they just have to move violently about. But modern life interferes with this exercise. I saw recently the cynical remark that we spend five thousand dollars a year to provide a bus so that our children may not have to walk to school and fifty thousand dollars so that they may have a gymnasium where they can get exercise.

## *Art and anatomy*

Man is an imitative animal and it is worth while to hold up to him good examples. For this reason anatomists and physiologists have been disturbed by much of the work of artists. Many artists proudly tell us that they are not attempting to depict nature. This is all right by us. We are not disturbed when Epstein sculptures a man or woman who would make a gorilla look by comparison like a fairy prince. We looked with

equanimity a generation back on a collection of straight lines, triangles, and rectangles called "Nude Descending a Staircase," for Carolyn Wells expressed our attitude:

Oh, see the Nude
Descend the Stair:
Fear not, oh prude,
To see the Nude;
*For by the road,*
She isn't there!
Oh, see the Nude
Descend the Stair.



danus von Swanenburg (1610). *The anatomy theater at the University of Leyc*

William Hogarth (1750), cartoon depicting the "Reward of Cruelty" in the guise of an anatomy lesson. In the seventeenth century, anatomy became a highly scientific study in Europe, particularly in Holland, and the work of doctors and surgeons was a popular subject for painters.

Certainly there was nothing pathological, that is, diseased, to be seen in this female.

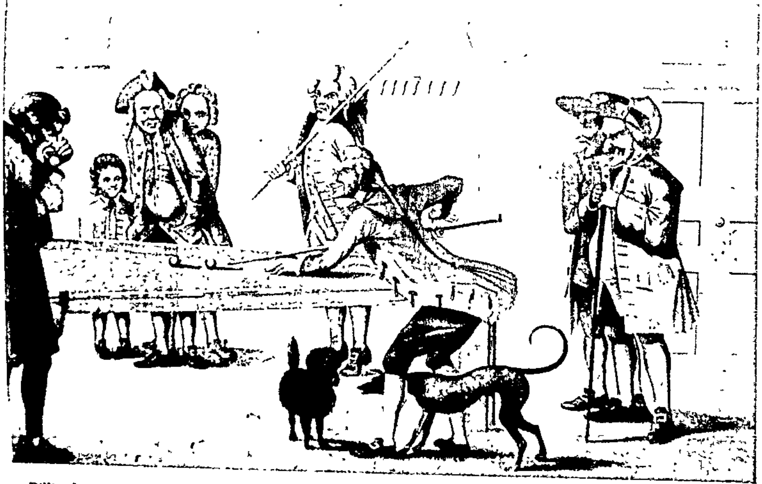
But many artists who were supposed to be depicting normal human beings have shown a fondness for distorted nature. A few summers ago I was privileged to see again some of the paintings of Peter Paul Rubens. His characters usually have their clothes off so that it is possible for a physician easily to estimate what life insurance companies feel is important, the relation of their weight to their height. They are grossly obese. None of them could get life insurance. It seems certain that many of them are doomed to diabetes, fatty degeneration of the heart, or other "morbid" conditions associated with overweight.

In the eighteenth century men were likely to be shown as short, squatty, round shouldered, potbellied and spindle shanked; some even appeared to be hunchbacked. Tuberculosis of the spine was at that time first described by Percival Potts so it undoubtedly was common and influenced the artists. Except in the times of the Greeks, artists have always been fond of orthopedic abnormalities. I was looking at an old illustrated Bible today. Many of the great religious characters had their feet turned out in extremely deformed positions. Take the head – the old masters showed their children as microcephalic (that means with minute heads). Such children, if the condition is really extreme, are usually idiots.

And now we come down to the commercial "art" of the present day. To be a dress model, a girl evidently has to be round shouldered, constricting her chest so that she cannot breathe well. Her belly sticks out so that again she can't do any good abdominal breathing. Her feet are turned out so that she could not think of moving with ease and grace and this accentuates her knock knees. Strangely enough the young men are good physical specimens.

### *The hand*

In all the above dissertation on bones and muscles there is little said that does not fundamentally hold true for the higher animals. To be sure, animals designed for weight and strength



Billiards in 1760. Men were four or five inches shorter then than now. Several of the men pictured here probably have tuberculosis of the spine, which produces "hunchbacks."

differ from those who are light and swift, and man, traveling erect on two legs, naturally has been forced to make adjustments for this. Yet the same bones and muscles, although strangely modified in size and shape, may be found in man and many animals. In our college biology course we certainly could not get human bodies to dissect, yet we did very well with cats. The only difference I remember distinctly is that our collarbones are firmly attached at each end. Those of cats float unattached in muscles.

However, in one most important arrangement of bones and muscles, man is unique. In fact, man's complicated and clever hand gives him such an advantage that, combined with his great forebrain and his speech, he easily dominates the powerful and swift animals who possess so many other natural advantages.

The hand allows man to use tools. If you have watched the cleverest trained ape use the simplest tool, a spoon for instance, you realize that he really has a modified paw. He has nothing like the range of motions of a human hand. No wonder that we speak of a good workman as being handy with his tools.

Small as the hand is in comparison to the rest of the body, it has twenty-seven bones, counting those in the wrist; and there are nearly half a hundred joints. There are so many ligaments supporting these joints that I doubt if they all have names.

Right here you should be reminded that in speaking of the front, back, inner, and outer sides of the hand, we consider the man as standing upright with his little fingers to the seams of his trousers and his thumbs out. Hence the palm is the front, even though when you are standing at ease or walking about you habitually hold your hands in the opposite position. There is rather a small amount of motion in any of the joints and the direction of the movement is usually very limited. Compare them with the shoulder joint which with the aid of some motion in the shoulder blade allows the arm to move across the front of the body for 360°, a full circle, and about three-quarters of a circle in a plane at right angles to this, not to mention much motion in the third plane.

The one finger that really has a fair amount of varied motion

is the thumb. What a foolish metaphor we use when, in speaking of a man who is clumsy with his hands, we say that he is all thumbs. Lose your thumb and your hand is not much better than an elaborate hook. Your forefinger is easily the best of your four fingers, but, if you lose it, you soon learn to substitute your middle or even your ring finger. You cannot substitute a finger for your thumb.

This is because the thumb is set off to one side with an arrangement of joints and muscles very different from that of the fingers. This allows the front or working part of the thumb to be opposed directly to the front of the fingers. The most delicately sensitive skin of the body is found on these soft front pads. So highly may the feeling and finely adjusted motions here be developed that we often speak of the "educated finger" of the surgeon.

The motions of the digits require many muscles, some of which start as high as the elbow and have long tendons running through tunnels. Who of you ever heard of the seven interossei and four lumbrical muscles of the hand? Yet these eleven little slips allowed Benvenuto Cellini to fashion his magnificent jewels and Fritz Kreisler to charm us with his violin. Either man could have lost many pounds of thigh or calf muscles, of which you are so well aware, yet the world would have lost little.

In order that the complex mechanism of the hand may work so wondrously, it is abundantly supplied with blood and nerves. All of you have had your pulse taken at the wrist. Your nurse or doctor counts beats here because there are few places in the body where so much blood surges through an artery near the surface. Yet I can assure you that if that radial artery is cut, plenty of blood will get to the hand by other routes. Nature intends to look out for that important hand.

Nature has also provided plenty of nerves to move all these important muscles and give plenty of feeling. The ulnar nerve is over on the little finger side, the median in the middle, and the musculo-spiral on the thumb side. A warning may be issued right here. If these names are really important to you, look them up. I may be using old-fashioned names. In my student days we called the first bone in the wrist the scaphoid,

which is Greek for "like a boat." A young physician just graduated would not now understand me, for he says "navicular," which is Latin for "like a boat." In my childhood, the oldsters were buried by undertakers. Later when I began to sign death certificates they were collected by morticians. Now I find from

Achilles bandaging Patroclus' Wound. This vase painting of about 400 B. C. is one of the earliest representations of the art of medicine. *(Bettmann Archive)*

the yellow pages of the telephone book that funeral directors have taken over. Fashion rules in anatomy or death.

Many of the nerves of the body have a specialized function. They are either motor for moving muscles, or sensory for feeling. The nerves of the hand are mixed. Thus the ulnar moves some muscles, especially the smallest giving the most accurate movements. But it also gives feeling in the skin. If

the ulnar nerve has been cut, a pin prick will not be felt on the little finger or on the adjacent half of the ring finger. The feeling of the other side of the ring finger is supplied by the median nerve as are the other fingers. The musculo-spiral supplies little feeling in the skin. I do not expect you to remember all this but you can see that a surgeon who does can tell pretty well what nerves have been injured. The palm of the hand may in the manual laborer become very tough and calloused and yet retain much sensitivity and pliability. Its toughness and strength are due to the fact that beneath the skin and firmly attached to it is a sheath of so-called fascia which is very dense, strong tissue. The anatomists describe three main furrows or creases which allow the necessary pliability. There are always numerous minor creases on which palmists base their interpretations of character. It is safe to say that palmistry's occult claims are analogous to those of phrenology in the last century. Bumps on the outside of the skull were then supposed to reveal the inner secrets of men's personalities. They were more likely to be due to accidents.

But no part of the body is entirely sufficient to itself. Some of the motions of the hand, for instance, start at the elbow. Possibly a professional pianist could earn a living if his hands were always held palms down, but I cannot think of any other workman who could do his job without some roll of the hand which has to start at the elbow.

## *The many functions of the bones, joints and muscles*

On a first consideration it would seem that the bones, joints, and muscles should be discussed from a mechanical and engineering point of view; always with the appreciation that they are imbued with that mysterious quality, life. This allows them to grow, renew themselves after wear and tear, and repair themselves after being broken and torn apart. They make up a machine of enormous complexity but with the advantage of taking care of itself. Nothing else in this world can take the abuse which the living body does.

But this is a small part of the story. Always nature has more than one use for any system of our body. The solid bone makes

the framework, but it is also a storehouse of such things as calcium and phosphorus, which are needed for the chemistry of the body and which in emergency can be dispensed by the bones. Most remarkable is the manufacture of the blood cells in the marrow of the bones.

Were one asked the function of the muscles, the obvious answer would be that they move the framework. I know that I cannot tell all that muscle tissue does. It helps in the circulation of the blood and the lymph; it stores sugar, which can be released and burnt for quick energy; its contractions produce heat and the resulting waste products help to stimulate respiration. Living tissue deteriorates with disuse so that the enthusiasts for physical exercise have a lot on their side.

Even if you can afford to pay for transportation, you had better keep your muscles in shape. Remember Whittier's Barefoot Boy —

> Let the million-dollared ride;
> Barefoot, trudging at his side,
> Thou hast more than he can buy.

# 3.

# General Delivery

## CIRCULATION

Man has always been acquainted with blood. Inevitable wounds caused it to flow and the spurting from arteries showed that there was great pressure back of it. Yet it was not until the time of the Pilgrims' coming to America that William Harvey showed how the blood was continually pumped by the heart through the arteries and returned by way of the veins.

Harvey was one of the great observers. Philosophers had said that the hen broke the egg open to free the chick. Harvey looked and found that the chick itself did the pecking open. After he had studied at Caius College, Cambridge, (pronounced "keys" and still the great training school for English physicians) he began to study the heart and blood vessels in men and animals. It was known that both arteries and veins were filled with blood, but it was thought that it just surged back and forth. Harvey studied the action of the heart; he saw that the valves prevented back flow; and he estimated the capacity of the heart and the rate of the flow. When he was through, there was no disputing his theory of the circulation.

William Harvey (1578–1657), the discoverer of the circulation of the blood, 1620.

During the English Civil War he was an intimate of Charles I and accompanied him on his campaigns. There is a pretty story of his sitting under a hedge at one battle reading a book to the royal children, the Prince of Wales and the Duke of York, until a cannon ball grazed the ground near them. Charles lost the war and was beheaded, but Harvey was not bothered by the Parliamentarians. He was evidently somewhat the type of his namesake of whom Samuel Johnson said, "If you call a dog *Hervey*, I shall love him."

We must consider Harvey's work all the more remarkable as we realize that he could not know or demonstrate part of the course of the blood. It was some years later that the microscope was perfected so that Malpighi could see and describe the capillaries. These are the minute vessels through which the blood gets from the arteries to the veins; they are so small that the red blood corpuscles have to go through single file. In the days of small distances we were impressed to learn that if all one's capillaries were placed end to end they would reach two and a half times around the earth at the equator.

## *The circulatory system*

The heart is a big muscle and there is no other like it in the body, for if a little piece of it is examined under the microscope its fibers will be seen to be entirely different from all other muscle fibers. It is tough. You are persuaded of this when you bite on a piece of chicken heart in giblet gravy, or when you consider the heart of an elderly person which was beating many times a minute before birth and is still going strong ninety odd years later. Its only rest day or night is what it can get between beats. If it stops for more than a few minutes, that particular life is ended.

If you are sitting quietly reading, not excited by my gentle tale, fresh blood is coming from your left auricle, a thin-walled chamber at the top of the heart, at the rate of about five pints a minute. It passes through the famous mitral valve into the left ventricle, a thick-walled, powerful pump that sends it through the aortic valve at the top of the heart. From here it is carried by the aorta, a great artery which twists completely

around and runs down the body, giving off big branches at frequent intervals. With the recurring subdivisions the final effect inevitably reminds us of a tree. After the blood has been thus distributed to every nook and corner, passed through the capillaries, and gathered up by the veins, it is returned to the right auricle, another thin-walled chamber at the top of the heart.

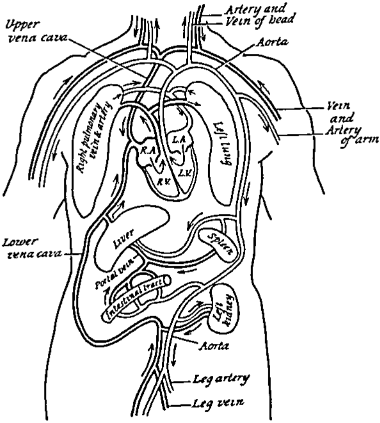



Diagram of the circulatory system. The aorta and vena cava actually course along the midline of the body. In each organ the arteries divide into smaller vessels and capillaries (not shown). Vessels containing oxygen-poor blood have dark outlines. (*Carlson & Johnson*, The Machinery of the Body, 4th Ed. *p.* 125. *The University of Chicago Press*, 1953. *Reprinted by permission.*)

All this makes up the chief of the three circulations of blood. It is the internal transportation system, doing the freight work of the whole body. But the body, like great modern states, is not self-sufficient. In fact it has to import all its raw materials through the lungs and digestive system, with slight help from the skin. There are two accessory systems handling these imports.

The pulmonary system connects the heart and the lungs. The blood which has been carried all over the body has given off oxygen to the tissues and in return has taken away the carbon dioxide which results from the oxidation, or burning of these tissues. This blood, which is rather blue when it arrives at the right auricle, is now transferred to the pulmonary system. It passes through the tricuspid valve to the right ventricle, another powerful muscular chamber. Here it is pumped through the pulmonary artery which distributes it to the lungs, where the carbon dioxide is given off and oxygen absorbed from the air that has just been breathed in. Now, refreshed and pink, it is returned by the pulmonary vein to the left auricle, ready to be distributed to the body again.

The other accessory circulation is in the abdomen and is called the portal system. It collects blood from the intestines, where it has been loaded with the products of digestion. Then its chief vessel, the portal vein, carries the blood to the liver, where it is processed further. Finally all this blood is again collected from the liver and returned by the hepatic vein to the vena cava, the great vein which empties into the heart.

## *The blood vessels*

The fine subdivisions of blood vessels result in every minute portion of the body getting supplied, as you may readily realize when you consider how even a pin prick produces bleeding. A little way back the resemblance of the blood system to the branching tree was suggested. It has often been so depicted. But if a branch is broken, the leaves at its tip wither. Such a calamitous result is uncommon in the body, for the blood system really is like the network of highways in the country. If the main route is blocked, it is bothersome, but traffic can be

rerouted. The side routes for the blood are referred to as collateral circulation. John Hunter, the famous eighteenth-century English surgeon, did a great deal to study and describe these side circulations.

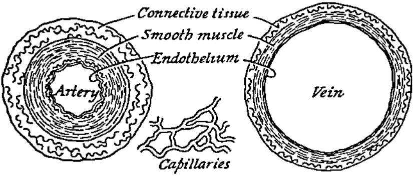
His most famous experiment consisted in tying the vessels which carry blood to a deer's antler. One would naturally suppose that this constriction would interfere with the growth of the antler, but Hunter found that other large vessels appeared, or at least enlarged so that they became noticeable, and the antler continued to grow.

We used to think that there were a number of places in the body that were supplied by what we called end arteries; that there was only one route for the blood to traverse, and if this was blocked then no blood reached the part. The more the matter has been investigated, the more we find that this is not so. The coronary arteries in the heart were among the last to be proved to have this side circulation. Recent investigations have shown that coronary arteries can be blocked off and in many instances the blood does get to the tissues by side routes.

There is a theory that in the early stages of life all these vessels are equally important, but then some one vessel takes over most of the load and the others do not develop. When your pulse is counted, the throb comes through the radial artery in the wrist for that is carrying lots of blood to your very important hand. Most of you could find no evidence of blood getting through by any other channel. Yet the radial artery can be cut and tied off, and other vessels will take over the work with very little difficulty.

The veins which bring the blood back have even more side routes to help out. The circulation of blood in the brain has to be carefully adjusted. Too little or too much makes a great difference here. The jugular veins, one on each side of the neck, are tremendous big pipes; but when we dissect the side of the neck, as we frequently do for cancer, we think little of removing the jugular. That big flow of blood goes off by other channels and the brain minds it not at all. The patient may be up and around the next day. Nature is a good traffic engineer. She can adjust to peak loads and times of light traffic more successfully than is done on our streets.

**The arteries.** There is a striking difference in the structure and appearance of the arteries and the veins. The walls of the arteries are three layers thick, with muscles in the middle layer, the outer layer being tough and elastic. They hold their shape even when not distended with blood. The veins, in contrast, are thin and have little elasticity so that when empty they are hardly noticeable, and thus may be especially bothersome for surgeons. An artery stands boldly forth. One may see or feel its beat. If it is cut, the spurting blood tells where to seize it. But a big vein with soft weak walls cannot be told from other tissue when pressure has caused it to collapse. After the pressure is released, the blood oozes up from one knows not where.




Structure of artery, vein and capillaries. (*Carlson & Johnson,* The Machinery of the Body, 4th Ed., *p. 164. The University of Chicago Press, 1953. Reprinted by permission.*)

Right here is probably the best place to talk about the control of bleeding by amateurs. The first-aid manuals have told people to use tourniquets. I believe that in the overwhelming majority of cases the tourniquet is unnecessary and is usually harmful. It is not a simple thing to apply a tourniquet efficiently. The arteries are deeply situated and stiff-walled, and hence difficult to compress to the point where bleeding is stopped. But the veins are superficial, flimsy, and easy to compress. It is difficult to tighten the tourniquet evenly to the point where it will stop arterial flow. Doing so causes great pain. I have no doubt that in a large majority of cases the blood keeps going through the arteries, but the pressure stops

the return through the veins. Result – increased bleeding. Fortunately it is a rare case where bleeding is not stopped by clotting in the wound, especially as the low blood pressure resulting from shock or fainting hastens the clotting. Pressure over the point of bleeding is the best procedure for anybody but an experienced surgeon to use.

The arteries in early life are elastic and their diameter may enlarge or shrink from time to time according to the action of the muscles in their walls. The individual has no command over these muscles as their action is regulated by the involuntary, or sympathetic, nervous system. These nerves can be affected in various ways, as for instance by drugs, called vasodilators and vasoconstrictors. Nicotine is a vasoconstrictor. In such a condition as Buerger's disease, in which the diameter of the vessels to the hands and feet is lessened, smoking is always forbidden. Emotions temporarily affect the size of the arteries. Thus blushing, resulting from shame or embarrassment, is due to the dilating of the small arteries in the skin.

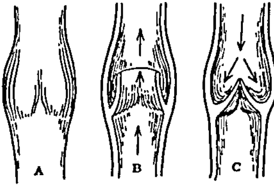
*Hardening of the arteries.* In early life the inner lining of the arteries is smooth, but with advancing years the well-known arteriosclerosis, or hardening of the arteries, may develop. Arteriosclerosis is still a mysterious matter. I just felt the pulse on a seventy-five-year-old man whose radial artery in the wrist was perfectly smooth. In much younger men it often feels like a string of beads. The hardness and irregularity is generally due to deposits of calcium, the chief ingredient of oyster shells, egg shells, etc. Hence the appropriateness of the phrase – pipe stem arteries.

Another substance blamed for hardening of the arteries, particularly those of the heart wall, is cholesterol. The drinking of milk is supposed to produce cholesterol in the body. Cholesterol is soluble in alcohol. Observing these phenomena, Dr. Timothy Leary, for a long time medical examiner for the Suffolk district in Boston and also a professor of pathology, studied the problem further. Only man and his domestic animals drink milk after infancy. Coronary sclerosis, or hardening of the arteries of the heart by cholesterol, is peculiar to man. Dr. Leary did autopsies on several hundred alcoholics at a state home for inebriates. He found their coronary arteries

so smooth that no similar sized group of clergymen could equal them in this respect. It would seem that overindulgence in either milk or alcohol may lead to disaster. Recent studies, however, appear to indicate that a high intake of various kinds of animal fats may be a cause of arteriosclerosis, which is rather uncommon in countries where people are poorly nourished and live to a large extent on vegetables and fruits.

**The veins.** The veins decidedly have not the virile character of the arteries; they have not the musculature, elasticity, and firmness. Their walls are thin, flabby, and not at all tough. By the time the blood has got through the narrow capillaries, the pumping force of the heart has been expended and instead of a raging torrent there is a dull sluggish backwater. Cut an artery and the blood spurts into the air; cut a vein and there is a welling-up like an overflowing catch-basin after a heavy rain.

What forces carry the blood back to the heart? First, I suppose, is the suction effect as the heart, having contracted, then expands, leaving an empty chamber free of pressure. The elasticity of the tissues of the body presses on the veins, and muscular movements increase this pressure. The veins have valves which allow the blood to move only towards the heart. When the body is in good condition, these factors are sufficient.




Valves in veins. A. Swollen vein from outside, indicating presence of a valve. B. Valve open, allowing flow of blood. C. Valve closed, preventing backflow. (*Walter & Sayles, Biology of the Vertebrates, p. 345. W. B. Saunders Co., 1949.*)

*Varicose veins and related diseases.* You may imagine, though, that this equilibrium is easily upset. Some persons have an hereditary weakness or absence of valves. Pressure on the veins, as by tight circular garters or by the heavy uterus of pregnancy, or the back pressure from a chronically sick and inefficient heart, may result in dilated veins. These are called varicose veins, a redundancy as the word comes from the Latin *varix* which in itself means an enlarged vein.

Varicose veins may appear in many parts of the body; for instance hemorrhoids or piles are due to them, but the common place to see them is in the legs. Quadrupeds who usually travel on all fours do not put great strain on the veins of the legs, but when man got up on two legs these veins had to stand a pressure of four or five feet. They frequently do not do it well.

So people who spend long periods on their feet, particularly if they reman in one spot, are likely to have swollen veins. They are common in women. One sees many women, middle aged or a little older, who complain of tired swollen legs and feel that their housework is too much for them. Many of them have some constriction by round garters, tight girdles, or rolled stockings. Nowadays most of them have "good" modern kitchens, so compact that everything can be reached by few steps. Webster's dictionary says that "limbs lose strength by disuse." The swelling of the ankles and the enlarged veins are often due to the muscles' failure to help the circulation of the veins. A reasonable amount of straightforward use of a woman's muscles of locomotion will help to maintain a trim unswollen ankle and more comfort.

When the veins are badly varicosed and the circulation is poor and fluid collects in the tissues, it follows that the nourishment of these tissues is poor, especially in the skin which is much exposed to injury. Wounds do not heal well under such conditions and varicose ulcers result. These are chronic, sluggish, open sores. In the good old days they were very common, and innumerable pastes, lotions, and ointments were invented for their treatment. A young doctor starting in practice was fortunate if he could get a few paying patients with this condition as he could make a frugal living dressing the sores;

and even if he healed them they would return when the patients again barked their shins.

Another serious aspect of varicose veins is the danger of thrombosis or phlebitis, that is, clotting within or inflammation of the veins. The two are frequently associated. One of the gravest dangers is that part of the clot may break away, be carried to the heart and then to the lungs. When signs of these conditions appear nowadays, surgeons are usually quick to expose the big vein in the groin and tie it off before "emboli," that is, clots, have broken away and landed in the lungs.

## *The heart*

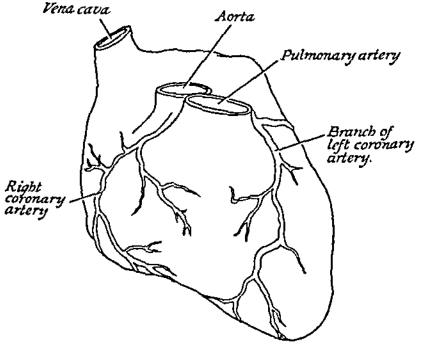
All the blood of the body goes through the heart twice a minute and a red blood corpuscle travels miles in its lifetime of a few weeks. Figuring on my pad, I found that it is not unusual for an elderly heart to have pumped half a billion quarts in its busy career, and the miles traveled by the succeeding families of corpuscles would total thousands.

That is a tough assignment for a heart, but it is difficult to exaggerate the wonders of this fairly simple piece of apparatus which is essentially a pump with four chambers and some valves. Fortunately for us, its muscle is very tough indeed; then like all our tissue, it is continually being repaired. You know that the better you keep your auto tuned up, the better it performs, and the longer it lasts. Finally, the heart's rest periods are frequent, even by modern standards. The average man's pulse is seventy to the minute and on each beat the heart gets four-tenths of a second's rest. So it gets ten hours' rest every day. It lies in a sac called the pericardium which contains a lubricating fluid so that there is little friction. Also it is well protected from injury by the tough and springy chest wall. Many a would-be assassin has found that the heart is a difficult thing to reach with a knife.

Although you all know that the heart is on the left, actually about one-third of it is to the right of the mid line. And all of you, having received Valentines, know its beautiful shape, but never have I seen anything in the chest resembling a Valentine. I have before me Cunningham's *Manual of Anatomy* and

its pictures suggest that the heart is nearly rectangular, although there is a hint of a point at the lower left called the apex. The great blood vessels coming off from the heart obscure its actual shape.

Its dimensions are roughly five by three and a half by two and a half inches, although there are variations according to the size and age of the owner, and after childhood, according




Shape of the heart. (*After Cunningham,* Anatomy, *p. 740. W. Wood & Co., 1903.*)

to sex. *The heart is estimated as being the size of a clenched* fist. A young girl's fist is just as big as a boy's. At the same age many a girl can lick a boy.

When one looks at the live, beating heart, it seems to be all of a flutter. As a matter of fact, the movements of a healthy heart are pretty definite. They begin up at the top and ripple down in the direction in which the blood is flowing. Every physician knows about the Bundle of His, although few see it often. It is a long winding strip of muscle which starts at the auricles of the heart and runs down to the ventricles. It is along this that the beat of the heart travels. When this routine

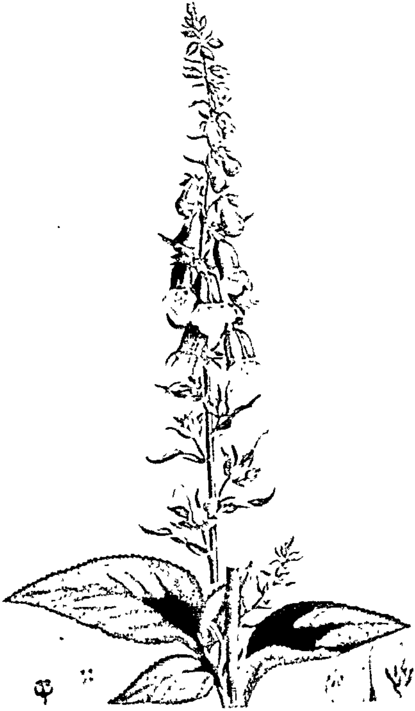
movement is interfered with in any way, the efficiency of the heart is affected. This activity seems to be controlled by several agents.

The two vagus nerves start from the brain and run down as far as the stomach, doing numerous chores as they go along. One of these chores is to vary the heart rate. Stimulation of the vagus will slow the heart. Then there are sympathetic nerves which hurry it up. And also there seem to be other influences in the heart muscle beside the nerves. A heart can work most efficiently, thereby sparing itself, if it may beat at a moderate rate. Unfortunately many hearts react to difficult tasks by increasing their speed. One of the most brilliant of medical annals tells how this was remedied by a great triumph of botany in medicine.

**William Withering and the use of digitalis in heart diseases.** About Midsummer's Day there may be found in old-fashioned gardens long spikes of purple bells, all hanging in one direction and beautifully spotted. This is the foxglove, or *digitalis purpurea,* a wonderful combination of beauty and utility, possibly surpassed in the flower world only by the opium poppy.

Illustrations of it in black and white are common, but the best showing of it in color that I have seen is at the Rhode Island Medical Library, for there is a copy of William Withering's book printed in 1785, entitled, *An Account of the Foxglove and Some of Its Medical Uses; with Practical Remarks on Dropsy and Other Diseases.* In the front is a sheet which when unfolded shows a spike of foxglove, full sized and in the same bright colors which it has retained for over one hundred and fifty years.

Withering lived in the age of Johnson and was a tremendously successful practitioner. It was said that in one year he traveled in his carriage 6,353 miles – not bad even for our automobile age. He was apparently not interested in accumulating wealth beyond what sufficed for a pleasant life, for his family and he always had a very large number of charity patients. It was an acquaintance with physicians like him that moved Dr. Johnson to say: "I believe everyone has found in physicians great liberality and dignity of sentiment, very



The foxglove, or digitalis. Illustration from William Withering's original book printed in 1785.

prompt effusions of beneficence, and willingness to exert a lucrative art, where there is no hope of lucre." Unfortunately, Withering did not publish his paper until the year after Dr. Johnson's death. The latter died of disease of the heart and kidneys; could he have had the benefits of digitalis, he might have had a few more years of comfortable and valuable life.

Among Withering's friends were such men as James Watt, inventor of the steam engine; Joseph Priestley, the Unitarian minister who isolated oxygen; Josiah Wedgwood, manufacturer of the famous pottery; and Benjamin Franklin, who wrote to Withering from Paris for medical advice.

Foxglove or digitalis had been known for centuries, but not much attention had been paid to its medicinal properties. In the year 1775, when this country was busy with such episodes as the Battle of Lexington, Withering was told of an old woman in Shropshire who had a secret remedy for dropsy. Perhaps this old-fashioned word is too much for you now. It just means too much fluid in the tissues. At any rate she was said to make cures after regular practitioners had failed. Although there were more than twenty herbs in the mixture, Withering's knowledge of botany told him: "It was not very difficult for one conversant in these subjects to perceive that the active herb could be no other than foxglove." Its chief effect was to slow the heart.

"Puking and purging" were popular treatments up to Withering's time and an overdose of foxglove caused these symptoms. Therefore, they were supposed to be responsible for the good effects. Withering realized that this notion was not correct; that the benefits without the disagreeable troubles would follow proper dosage. His book, which it is said he brought out sooner than he intended because of the misuse of the drug, laid down principles which still hold good.

The slowing of the heart by digitalis takes place mainly in diastole, or the resting time of the heart, which is certainly beneficial. The good effects are entirely due to efficient heart work promoting the circulation.

Withering and his friend, Joseph Priestley, were certainly great benefactors of mankind, and few men have been more kindly and altruistic than they were; but because their re-

ligious and political principles did not conform with the popular points of view, Priestley's house and papers were burned, and Withering had to hide his library and scientific collections and flee. Priestley came to America, where he died in Pennsylvania. Withering's health gave out and after a few years of invalidism he died of tuberculosis. Thanks to them, digitalis and oxygen save many a heart now.

Angina pectoris. Such a powerful great muscle as the heart, bearing the primary responsibility of keeping us alive, should and does have the first choice of blood refreshed by its passage through the lungs. At the very beginning of the aorta, where the blood is leaving the heart, are the openings of the right and left coronary arteries. As their name implies, they encircle the heart, liberally supplying the walls with blood.

Unfortunately it seems that no other arteries are so likely to have some of their branches closed off by thickening of the inner lining of their walls or the formation of clots. It seems also that this is occurring more frequently than formerly. Certainly we are more often recognizing it. Until recently it had not been understood or described, but because of the severe pain associated with an acute attack it was spoken of as angina pectoris, that is, a spasm of pain in the chest.

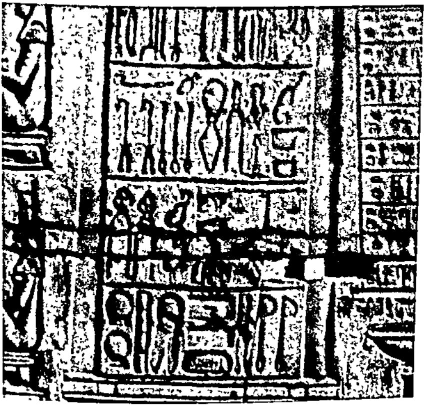
It is pretty certain now that angina pectoris is always caused by trouble with the coronary arteries. But not all pain in the chest is angina pectoris. In fact, I think that it is safe to say that most of it is not. Fortunately the more common pains do not mean that one is in grave danger. It is my impression that muscular cramps and aches lead all others as causes of discomfort here. Chronic coughs such as most of us have, resulting from our colds and attacks of bronchitis, or the ubiquitous cigarette cough, keep our muscles of respiration in a spasmodic condition, and muscles in spasm are decidedly painful. Particularly, I think, pains directly over the heart, which scare people, are usually due to muscle spasms.

An exceedingly common cause of pain in the chest is irritation of the esophagus, or gullet, which runs right down the middle. A "stomach specialist" recently remarked that most heartburn was irritation of the esophagus, rather than of the stomach. We now know that small hernias which let a

little of the stomach come up through the diaphragm are not too uncommon and cause a good many symptoms, and the chief symptom is usually pain in the chest.

Persistent chest pain should always be investigated, because of the off-chance that it may mean something serious, but in a large proportion of cases it is something that can be readily remedied.

The heart muscle is supplied with blood by the coronary



Medicine in ancient Egypt. Surgical instruments in the temple of Kom Ombo.

arteries and the most important thing that the blood carries is oxygen. When there is a lack of oxygen for a muscle, it causes pain whether in the heart muscle or leg muscle of a patient with arteriosclerosis. So you see that angina pectoris is only a symptom, and coronary disease is the cause of the symptom. A branch of the coronary artery may be in such poor condition that the portion of muscle it supplies may be destroyed by lack of blood. If the muscle thus injured is not

too extensive or in a vital place, the patient recovers and may carry on a good life for years.

People with angina may have arteries good enough to function well when everything is going slowly and quietly. Increase of activity calls for more blood than some part of the artery can let through. The muscle at that point suffers from lack of oxygen and distress results.

Many things cause this increase of activity. Muscular work is one of the most common. Heavy meals create a considerable demand for oxygen. Smoking increases the pulse. The most spectacular incitor of these attacks is emotion, such as excitement, anger, fear, and general anxiety. I don't believe it necessary to convince any of you that these will start your heart pounding. I had a friend who had a disease of the heart and who was not at all lamblike; in fact, he had a good deal of pugnacity. But one day I sat by as an acquaintance gave him a severe dressing down without receiving any return argument. He told me afterwards: "I didn't dare to get cross with him. It would have resulted in a terrible pain in my chest."

One feature of anginal attacks is an associated sense of impending death. There is nothing abstruse or especially significant in this. It is only natural that one who has heard many tales of such deaths should fear and expect a fatal result.

The average duration of life in these patients is now ten years. There have been reports of patients who have lived twenty and thirty years. I have lots of friends about who had attacks years ago. So do not quit, but take things easy: avoid tobacco, overeating, and excitement; let your doctor help you out with drugs as indicated, for in certain cases drugs are very helpful.

Even at that I may be emphasizing too much the need for carefulness. It is still true, as Dr. Heberden, Samuel Johnson's physician, who described angina pectoris, wrote in the eighteenth century: "Many physicians appear to be too strict and particular in the rules of diet and regimen, which they deliver as proper to be observed by all who are solicitous either to preserve or recover their health."

Tobacco, work, and heart diseases. Tobacco has always

been thought bad for people with heart disease. The writer of one of our best modern books on treatment says: "When, as, and if I get a coronary, I will, if I can, give up smoking. . . ." Many people get so much contentment out of smoking that it may be worth while to allow them to use it in moderation. Then about stairs: this ranch-house generation thinks that stairs are poison for anybody and sudden death for everybody with heart lesions. Take them slowly. My wife's aunt had a very, very bad heart and she lived in a third-floor apartment without an elevator. But she was an indomitable old lady and she took ten or fifteen minutes to make the trip and got away with it for several years. Do not always take too pokey a pace. It always seemed to me that walking as in a wedding procession, balancing on one foot at a time, was not an easy way to get on.

Most cardiac patients are able to work at light tasks. Certainly they should not be kept in bed if it can be helped. The use of a bedpan is very hard on heart cases. Do not depend too much on low fat and low salt diets for they both are uninteresting, leading the patient to cheat, and a low salt diet may actually be dangerous. Bernard Shaw said: "The doctor may lay down the law despotically enough to the patient at all points when the patient's mind is simply blank; but, when the patient has a prejudice, the doctor must either keep it or lose his patient."

One summer several of us were talking together and one man, not a physician, spoke of the danger to the heart from too heavy work. He told this story. While on a vacation in the White Mountains he noticed a fine-looking man in the prime of life who seemed to have nothing to do. Refusing to climb or even play golf, the newcomer explained: "I used to be too athletic. I rowed on my college crew and strained my heart. Now I can't do anything strenuous."

My guess is that his condition was one caused by the doctors he consulted. I have always known this disease and I have discovered, in a recent bulletin of the American Heart Association, that it has a name – iatrogenic heart disease (i.e., heart disease caused by a doctor). This is such an important looking and sounding word that I intend to remember it from

now on. The ailment is found in the type of patient who tops off eighteen holes of golf with several cocktails, a big dinner, and a few highballs. Not feeling well the next day, he goes to a doctor whose most violent physical exercise is shuffling the cards for contract. Perhaps the doctor hears a heart murmur. Lots of strong, healthy people have them.

So the physically indolent doctor tells the husky athlete that he has a strained heart muscle and must never be strenuous again. This is not so crazy as it may seem, for we can easily find arguments against the things which we do not like. I have known a number of such cases and the American Heart Association thinks it worth while to put doctors on their guard.

Many people worry needlessly about heart murmurs. Keats' brook might flow quietly around a curve, "How silent comes the water round that bend," but just as naturally a stream may gurgle while it flows. This thought illustrates the fact that often a heart murmur has no significance. Dr. Paul Dudley White, who has devoted his life to the study of the heart, lends weight to this by his statement: "Patients should be told that many murmurs are normal. It is really surprising that murmurs are not found in every heart, normally."

At the present time, heart disease has become a most important question. There is no doubt that many people have wrong ideas about what hurts the heart. Enlargements of the heart are the results of previous disease and the healthy heart will not dilate beyond normal limits. A bout of strenuous exercise will not strain it nor cause it to fail. If you do not like to exercise, do not do it, but do not use your heart as an excuse.

## *Blood pressure*

Another cause for worry today—due to that dangerous thing, a little knowledge—is blood pressure. Naturally the circulatory system in the human body, like a municipal water system, has to have pressure to keep the flow going to where it is needed. In my home city, the great Corliss engine which for fifty years kept the water pressure high on the East Side

is spoken of with respect. Yet that is a short span for the human power plant, even in many cases where the blood pressure has to be kept high. This pressure is a bugaboo for moderns, whether high or low.

It was not until the latter part of the eighteenth century, a century after Harvey described the circulation, that Stephen Hales, a Church of England clergyman, got the first information about blood pressure. He put a glass tube in the artery of a horse and determined just how high the pressure would force the blood. Also in this experiment he learned a good deal about the capacity of the heart and the speed with which the blood flowed.

Cutting down on the blood vessels and sticking tubes in them is such a difficult and bothersome way to measure blood pressure that there were no practical measurements until about the turn of the present century an Italian named Riva Rocci developed the sort of blood-pressure apparatus which we now use.

It is an unfortunate fact that people are greatly interested in their blood pressures. When the pressure is measured in a doctor's office, they usually ask the result and frequently volunteer a statement as to what it was before. This is "unfortunate" because a casual reading of a blood pressure is in most cases of very little value.

The reading referred to by the patient is the systolic, which is the highest pressure reached. Systole is the contraction of the heart by which the blood is forced forward into the arteries. Then the heart relaxes, the pressure drops down, and the lowest reading is the diastolic. Diastole is this rhythmical expansion or dilatation of the cavities of the heart during which they fill with blood. The diastolic pressure is really the more important, but it is not so spectacular and is a matter for careful interpretation by the physician. The two readings are recorded as — over —.

A markedly low systolic pressure is found when there is a large loss of blood or when a patient is in a state of "shock," such as results from severe injuries. Naturally these conditions are serious and must be treated promptly by blood transfusions, fluids, etc., of which we have all heard much in the

war years. A few diseases also are accompanied by low pressure, but in general low readings should not cause worry. Some of the hardest driving, most energetic people habitually carry low blood pressures.

Physicians are agreed that a single high reading, particularly systolic, means little. Some persons have great fluctuations for minor causes. A sudden slight fear or excitement such as might result from a visit to a doctor's office may give a startling figure. One elderly woman when examined by a doctor from out of town was trembling so with excitement

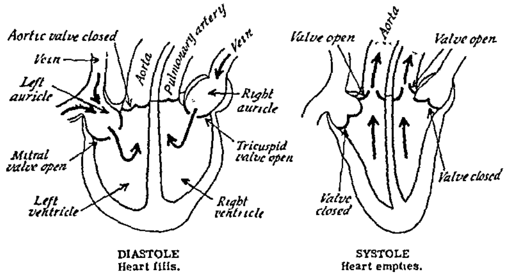



Diagram of a heartbeat.

that her systolic pressure was over 200. Daily readings made in her own home by her physician did not go over 120 in a fortnight.

There are certain people, however, in whom the blood pressure is continuously elevated well above the normal, although no evidence of underlying disease can be found. This is called "essential hypertension," weasel words which really indicate our lack of knowledge of the why or wherefore. It may be compatible with many years of health and of itself rarely produces symptoms. A physician friend tells of a recent study of one hundred cases of "essential hypertension" with excessively high readings observed over a period of thirty

years in which it was found that those who died had lived on an average to within two and a half years of their normal life expectancy, and 10 per cent had exceeded their normal life span. Several of these people had shown at times a systolic pressure of over 300 which is very high indeed and of which some of them were unaware. The symptoms of high blood pressure are often not caused by the pressure but by nervousness and worry, and often these are greatly increased by fears which have been excited by the very knowledge that the pressure is high. A wise physician seldom tells a nervous patient the actual blood-pressure reading.

There is on the other hand one type of high blood pressure which is called "malignant" because it is progressive and associated with damage to the heart, kidneys, and brain; it may be fatal in a comparatively few years. Fortunately it is a rare type, and when it is recognized early, an operation on certain nerves may be done. This may result in a return to fairly normal health. It is a matter of critical and difficult judgment to decide when such an operation should be done.

Certainly persons with high blood pressure should avoid strain and worry. If they do so they have an excellent chance of completing their allotted span of life.

Mankind takes its blessings and makes them calamitous. The internal combustion engine and the sphygmomanometer, or blood-pressure apparatus, are examples. No single invention could have contributed more to man's happiness than the engine, but it was used to make possible the most devastating war ever fought. Unimportant blood-pressure readings have caused so much worry in patients and in forced meddlesomeness by physicians that the loss of all the instruments for measuring your pressure might on the whole prove a benefit. Just ignore your systolic blood pressure.

## BLOOD

The blood which the elaborate circulatory system carries about so expeditiously is a watery solution of salts, minerals, food substances, and waste products, to give part of the list.

Floating in it are the blood cells. They are mostly red cells, or erythrocytes. Statements as to their number sound like the federal budget. There are about five million in a cubic millimeter. As a millimeter is something like a twentieth of an inch, this is a small space to hold so many. The body is said to contain two hundred fifty billion of them.

It has been determined that the length of life of a normal red blood cell is about 120 days. Some mathematician, or at least arithmetician, has figured out that this means that they are made at the rate of three hundred thousand a second. Women, whose bodily functions ordinarily go on at a slower rate than men's, have about nine-tenths as many as men. Also, of course, it must be remembered that throughout a considerable portion of a female life there is a monthly loss of blood by menstruation. The fluid loss is quickly replaced, but the loss of red corpuscles much more slowly.

I do not think that the shape of a red blood corpuscle is too definitely known, but it seems to be disk shaped. This gives a great deal of surface in proportion to bulk and our arithmetical friend who deals in large numbers has figured that the combined surface is equal to four baseball fields.

Mixed up with these red cells are the white cells, or leucocytes, of which there are usually in the neighborhood of eight thousand to a cubic millimeter. There are a number of varieties; usually the majority are polymorphonuclear leucocytes. I mention this long name because they are very important. The long word means "many forms of nuclei." The nucleus is the center and headquarters of a cell. These p.m.l's, which alphabetical lingo I am sure you will forgive me for using, fight our battles for us in many types of infection. Dying in our defense, their dead bodies form the familiar pus. In appendicitis or pneumonia, to cite familiar examples, the "white count" is apt to rise from 8,000 to 15,000 or 18,000 or higher; and instead of, say, 70 per cent being p.m.l.'s, there may be 90 per cent. There are other types of white cells, the most common being the lymphocyte, which sometimes occurs in incredible numbers in the disease so often heard of in the news nowadays, leukemia. Also blood platelets, which look

to the eye like small fragments of cells, occur in many hundreds of thousands to the cubic millimeter.

The red cells are composed mostly of hemoglobin, a compound of iron which takes up oxygen as it streams through the lungs and gives it off just as promptly to the tissues. Having delivered the oxygen, the cells then take up carbon dioxide and carry it to the lungs where it is given off in the breath. You may see now why there is such an enormous extent of surface in the body of cells, as these gases have to pass through the surface. *Unfortunately there are certain* substances which are absorbed many times as easily as oxygen. Among these is carbon monoxide. That is why the exhaust from an auto in a closed garage may cause death. The red hemoglobin has tremendous staining qualities; a few teaspoonfuls in a bucket of water quickly transform it, in the eyes of the startled onlookers, to a bucket of blood.

Although the red cells are the most prominent part of the blood to our inquiring eyes, actually two-thirds of our blood is a fluid called plasma, which is 80 per cent water and has very little color. It is really most important, however, for besides furnishing water transportation for the red cells which would otherwise get nowhere, it carries food materials to the cells and waste products to the kidney and skin where they are eliminated. Other things too numerous to mention are also thus moved about.

## *Anemia*

Anemia, or lack of blood, is a common condition in human beings, although many make such a diagnosis on themselves without proof. Mere pallor does not necessarily signify anemia; it may be due to lack of the ordinary amount of pigment in the skin. Conversely, in our modern days when our females have borrowed all the arts of the savages, the chief mark of this condition is well hidden by cosmetics. There are innumerable causes for anemia; certain severe diseases are associated with it, but the one outstanding cause is loss of blood. It is easy to recognize the condition when big hemorrhages occur,

but far more often it follows small repeated bleedings from hemorrhoids, "stomach ulcers," and other conditions of which the patient may not be aware.

Hemorrhages cause loss of hemoglobin and practically that means loss of iron. Under ordinary conditions a good diet furnishes all the iron necessary, but an anemia is evidence that conditions are not ordinary. Granted that the hemorrhages are controlled, *iron is almost a specific for rebuilding the blood.* For over a century Blaud's pill, which contains iron, has been famous. But iron is given in many other forms that possibly may be better, so understand that I am not writing a prescription.

Although the anemias due to *iron deficiency* are easily the most important because of their great numbers, another type is more spectacular, and until recently, not amenable to treatment. Thomas Addison of London described it a century ago and it has been called *pernicious anemia.* A few years ago I heard Dr. William B. Castle, of Boston, one of the most brilliant of the men who worked on the problem, tell us the story which he called, "Fun in the Bone Marrow."

The red blood cells are formed in the bone marrow. If a patient has pernicious anemia, the number of cells in the blood is greatly reduced and the marrow is filled with unusual cells. Although Addison recognized the disease a century ago, no progress in the treatment of it was made until George Minot, of Boston, knowing that foods high in protein, such as meats, benefited a little, tried out a series and finally in 1925 discovered that a diet of liver controlled the disease.

The trouble was that the patient had to eat about fifteen ounces of raw liver daily and most of them preferred to die rather than do this. So Dr. Minot extracted the juice and gradually concentrated it. Then with Edwin J. Cohn, Ph.D., of Harvard, he did a "chemical dissection" of liver. They finally produced a yellow powder, a few teaspoonfuls of which taken daily controlled the disease. They continued their refining, and now patients can keep free of trouble by having injected into their muscles a teaspoonful of liver extract every three or four weeks. But it was not really known what the substance in the liver was that produced the result; so doctors, veterinarians, and chemists kept hunting.

Since persons with pernicious anemia have no hydrochloric acid in their stomachs, this organ was investigated. A substance known as folic acid was obtained. It will cure some anemias and help pernicious anemia, but it does not completely do the trick. Then the veterinarians got into the game. Animals called ruminants or cud chewers, such as cows and sheep, have four stomachs. It was found that bacteria acting in the first stomach, called the rumen, produce the substance that prevents anemia. This is then absorbed as it passes along the intestines. Man also produces plenty of this in his large intestine but it cannot be absorbed here.

In certain parts of the world, as Australia and New Zealand, cattle have a disease with the signs and symptoms of pernicious anemia. It was shown that there there is a lack of one of the minerals, cobalt. Give the cattle a minute amount of this and they are O.K.

Now a substance called Vitamin $B_{12}$ has been produced that appears to be the long-awaited liver extract factor. This has a purplish hue which is shown to be due to the cobalt in it. If you should take a lump of domino sugar and break it into four parts, then one millionth of one of those parts would equal the amount of Vitamin $B_{12}$ which, given every few weeks, would control a patient's pernicious anemia.

Now all this may appear a little confusing to you. I merely wanted to hint how laboratory workers examin'ng stomach and intestinal contents, practicing physicians, hen fanciers. cow doctors, geologists, etc., have all worked together as a team and in a quarter century have taken pernicious anemia patients off a diet of raw liver daily and kept them in good condition with an occasional injection of five-millionths of a gram (0.000005 gm.) of Vitamin $B_{12}$.

## *Hemophilia*

Despite all these remarkable and interesting anemias, the one chief reason for a lack of blood is bleeding, whether by a sudden great hemorrhage or by steady day-by-day little losses. Of course all of us bleed at times and, were it not for the remarkable phenomenon of blood clotting, we could not exist; for we are bound to have injuries. The manner in which blood

does clot is very complex, various different substances taking part and a whole series of intricate changes being involved.

There are unfortunate people who are born with some lack of these substances; at least the above changes cannot take place in their blood. We say they have hemophilia. This is a remarkable disease which was recognized almost as far back as biblical times and was clearly described nearly a century and a half ago. Because of its spectacular characteristics and

Daumier, *Nosebleed.* An old superstition advised the application of a key to the patient's neck to cause the blood to clot. *(Bettmann Archive)*

the fact that some of the royal families of Europe have been afflicted with it, the general public is fairly well acquainted with its chief characteristic, which is a lifelong tendency to prolonged hemorrhage in affected males.

If a man is a hemophiliac, all his sons are normal and cannot pass on the defect to any of their descendants. None of his daughters will be "bleeders," but half of them may pass on

the disease to half their sons. Likewise the same proportion of granddaughters may be "conductors" of the trouble.

Naturally all affected male children of such stock must be protected against wounds and abrasions. Transfusions of whole blood or plasma increase the speed of clotting. Even such small amounts as thirty to forty cubic centimeters of blood have been found to help when hemorrhage occurs. The results are not long lasting but the treatment may be repeated as often as necessary.

It has been said that hemophiliacs improve when manhood is reached. Probably the answer is that (1) the most severe cases die in early life, (2) the teething period is passed, (3) more discretion and less activity result in fewer injuries.

Little of value has been developed for prevention or treatment of this affliction. Theoretically the disease could be eliminated if all the children in such families, except the unafflicted males, would refrain from marriage or at least from propagation. Of course if we could get such cooperation as this we would put an end to nearly all human ills.

During the recent war a group of workers under Edwin J. Cohn, Ph.D., extracted from the blood a large number of different substances known as plasma fractions, with varying and remarkable functions. One of these, globulin fraction, hurries up the coagulation of blood and a portion of a teaspoonful of this is almost as potent in stopping bleeding as a small cupful of whole blood. It is thought likely that even more potent fractions will be obtained and furnish some further protection to these unfortunate "bleeders."

## *Clotting of the blood*

If the rest of us have these elements which the hemophiliac lacks, why is it that our blood does not ordinarily clot in our uninjured vessels but does clot in wounds and thus stops hemorrhage? There evidently has to be something abnormal to start clotting. Many things start up the reaction. Exposure to the air is the most common. That is one of the great beneficent gifts of nature. It is a pretty free flow of blood which is not stopped in this manner. Injury to the inside of blood vessels also helps the clotting. When doing surgery we seize

the ends of cut vessels with our clamps and tie them. By the time the ties have softened and loosened, the injury to the lining of the vessels has caused firm clotting and there is no more bleeding. Of course in the overwhelming number of small wounds which we all receive there are no surgeons around to catch the injured ends of vessels, but with some pressure at the site of injury to interfere with the flow of blood, the air and the injured insides of the vessels will soon put a stop to the bleeding.

But this great boon of clotting of blood can be turned to bad purposes. There are innumerable examples of serious injury which may be caused by clots such as the clots in the vessels of the brain resulting in shocks and paralysis; those in the small vessels of the leg resulting in ulcer or even gangrene; and, what we have heard of so much in recent years, clots in the coronary arteries of the heart. So you see there are plenty of conditions in which it might well be worth while to discourage the clotting of the blood. Substances which interfere with clotting are called anticoagulants. One of them has been used for centuries. There are worms which swim in the water and are known as blood suckers, or leeches. These worms have cervical glands (that is, glands in the neck) which secrete an anticoagulant. When a leech was placed on the patient by the doctor, it would secrete this substance beneath the skin, causing the blood in the neighborhood to be liquefied and so easily sucked out by the worm. Whether these leeches are used any longer, I do not know. They were used at the Massachusetts Eye and Ear Infirmary when I was a student. It is evidence as to their former importance that "leech" was the old term for physician.

In recent years there have been a number of substances used to delay clotting. Blood is stored for future transfusion by running it into flasks containing potassium citrate. More recently substances have been used within the blood vessels themselves. The earliest well-known one of this group is heparin, so named because there is much of it in the liver (or hepar) of dogs. Now, I believe that is it obtained on a large scale from beef livers. This is most effective when it is introduced directly into the blood vessels. Its action is quick, oc-

curring in a few minutes, and it is likewise of short duration. It is expensive and not easy to use, requiring close oversight.

More recently developed than heparin is dicumerol. It had been known for years that cattle would occasionally, for no apparent reason, begin to bleed, often to the point of death. This affliction was called the "sweet clover disease." Veterinarians found that it came when the cattle ate rotten common clover. Rotten clover, of course, is not hard to obtain, so dicumerol is relatively inexpensive and easy to administer, being taken by mouth. Its effect is different from that of heparin, as the change in blood clotting time does not occur for many hours. These two substances can be used in combination. Given at the same time, the heparin will act almost immediately and the dicumerol will later take over the job.

Medical men use these drugs for coronary thrombosis, that is, clotting in the blood vessels which supply the heart muscle. Surgeons use them when there is clotting in the veins of the leg. In the past this condition has been treated by tying the veins above the clot so that it may not break off and be carried to the heart and lungs. This latter is a surgical procedure and patients may feel as Emily Dickinson felt:

> Surgeons must be very careful
> When they take the knife!
> Underneath their fine incisions
> Stirs the Culprit—Life.

Actually I believe that life is as little endangered by surgery as by materials favoring bleeding. At present there seem to be advantages connected with each method. Decision must be made in each case as to what will be done.

## *The wonderful heart*

The circulatory system is most wonderfully organized. Nature has provided innumerable safety devices along its entire course so that major disasters may be avoided. But its center, the heart, is absolutely indispensable. When that is through, life is through. In the last analysis, every death is a cardiac death. A physician friend of mine, Dr. Alex Burgess, has described the working of the heart in a manner far more vivid

and convincing than the accurate interpretation of many electro-cardiograms. Remember that the heart is a pump: systole is its down stroke, forcing blood through the arteries; diastole *is* its up stroke, allowing the chambers to fill with fluid.

The Song of a Man's Own Heart

Systole-diastole the whole day through
In a never-ending sequence while you live by what I do
With your life blood passing through me in a cadence like a song
Systole-diastole the whole day long.

S y s t o l e - d i a s t o l e, the long night hours,
While you rest I still am working tho I'm garnering my powers
For the efforts of the morrow, for the travail and the fight
S y s t o l e - d i a s t o l e through all the night.

SYSTOLE! DIASTOLE! is it fear or is it rage?
*Or perchance it's joy that keeps me knocking 'gainst my bony cage*
You can sense my throbbing tumult as keen as joy or fear
SYSTOLE! DIASTOLE! when your mate is near.

SYSTOLE-DIASTOLE; you are prostrate on your bed
And the poisoned torrent rushes, clouding brain and aching head,
I, your ally in extremis, fighting fetid fever's powers
SYSTOLE-DIASTOLE, oh the long hours.

Systole-diastole now the race is almost run
*Long the years we've toiled together in the shadow and the sun*
May the germ cells of our offspring carry what of us is best
Systole-diastole, systole-diastole, s y s t o l e - d i a s t o l e, REST.

# 4.

# Intake and Outgo

## DIGESTION

It takes a great deal of material to satisfy the needs of the human body. A little something thin as sunbeams comes in through the skin. The lungs take care of the gases. Everything heavier is received and handled in the alimentary canal. Transformation of food and drink into tissue — to replace wear and tear and to grow — and into energy, is of course fundamental to all animal life. This is a chemical and physical change, and continues in man throughout his three score years and ten, or more.

Man, a highly developed mammal, consumes a varied diet, the chemistry of which is complicated. The wonder is not that he has occasional feelings of discomfort in his digestive tract, but that he can overwork this system as most Americans certainly do, and get by with it. He chooses what he puts into his mouth; then automatically a remarkable combination of

motion, secretions from glands, and chemical changes occur, starting with his saliva as his mouth waters at the taste, sight, or smell of (sometimes at the mere thought of) his favorite foods.

The food travels down through the ailimentary canal, mouth to rectum, normally in some four to six hours. During most of this passage, various juices pour or trickle into the food mass, the appearance of which gradually changes into a thin soupy liquid in the small intestine. Much of it here is in soluble form, ready to be absorbed through the walls of the intestine into the adjoining blood stream.

Of course much of this fluid is provided by our drinks, and as chemical reactions seem to progress best in a fluid medium the old taboo against drinking water with our meals *is* really ridiculous. Nevertheless, many persons, chiefly women, have *shown that one can subsist on very few drinks.* A large and important part of the fluid comes from glands. A gland is a collection of cells which forms and gives off to the body a secretion. Glands vary in size from some so small that the naked eye does not distinguish them, to the liver, weighing pounds.

## *The salivary glands*

The ones which force themselves most on our attention are the salivary glands of the mouth. You know that they are big enough to make *a lot of fluid.* But all along the canal are innumerable minute ones. Many of these secrete mucus, which lubricates. The others secrete "enzymes." Enzymes are substances indispensable to the chemical reactions of the body. They would seem to be practically infinite in number and we know of most of them only by the results which they accomplish. They will be discussed later when we come to vitamins and hormones, the three being said to be one family.

Some of these enzymes have been identified and collected and occur in large amounts. The *digestive enzymes,* of which I have seen eighteen listed, are in this class. A few are well known: *ptyalin* of the saliva which changes starch to sugar is one. Perhaps the best known is pepsin of the gastric juice

which certainly in my younger days everybody knew about. Every family bought it at the drugstore or got it in chewing gum. We were told that it came from the stomachs of hogs and digested protein. All of us medical students knew of the euphonious trio, trypsin, steapsin, and amylopsin, which comes from the pancreas and which transforms proteins, fats, and starches, respectively.

Although there is ptyalin in the saliva and it helps to digest starch, the chief use of the saliva is undoubtedly to soften food and make it easy to swallow. Several pints may be secreted daily. Americans apparently have plenty of saliva — at any rate, they have led the world in spitting, as has been commented on by English travelers. Mrs. Trollope in 1830 was disgusted with this habit; and later Charles Dickens, in his notes on his American tours, complained that Americans spat before him. Nowadays our supremacy in gum chewing, which, of course, keeps saliva flowing, makes several pints seem a reasonable figure.

Saliva is secreted by several sets of glands, the parotids in front of the ears being much the larger. I know not why mumps, or epidemic parotitis, which is so remarkably infectious, has a predilection for these glands. Neither do I know why in adult males the disease so often jumps to the testicles, often causing atrophy here. One of my internist friends told me that in the First World War the sickest patients he saw were those with mumps. For these reasons, I am inclined to think that one might find it the course of wisdom to let one's children have the mumps, as the disease is mild in youth.

## *The teeth*

While the motion of chewing increases the flow of saliva and thus helps soften food, the chewing itself is equally important in making what we eat more easily digestible. The toothless baby needs soft food; the dog, however, with his remarkable power of digestion, can bolt his meat in large hunks, including even bits of bone.

Man is provided with three kinds of teeth: the incisors, in front, to cut the food; the canine to tear; the bicuspids (or

pre-molars) and the molars to grind it. We start early with "milk" or temporary teeth, and at six or seven begin to shed these and replace them one by one with thirty-two permanent ones. Our teeth have a pulp or soft interior of tissue with blood vessels and nerves; these latter are what make a trip to the dentist a sad ordeal to many people. Outside the core are two layers, cementum and dentine, much like bone only denser; and the very outer surface, enamel, resembling porcelain. All these layers are alive.

A striking example of the value to people of their teeth, or perhaps the trouble they cause, is shown in the yellow pages of our city's telephone directory. The list of physicians, who take care of the whole body, is 111 inches long; that of dentists, who confine their ministrations to the jaws alone, takes up 59 inches, or over one half the length for physicians. The only inference I can draw from this measurement is that the teeth form the part of the human body least able to stand the "progress" of civilization. This is strange, for their importance in feeding and fighting caused them to develop early in the history of the race, and in an individual they form before the bones. Teeth decay even in wild animals and aborigines but contact with civilization speeds up this degeneration, and nobody really knows why this happens. There is much talk of the effect of acid in the mouth, especially from eating sugar since bacteria form acids from sugars and other substances. Of course infectious bacteria play a role, for the mouth is, in a way, the dirtiest part of the human body. This has been sadly realized by many a street fighter who beat up his opponent but cut his knuckles on the other fellow's teeth. The resulting infection was very wicked.

What is to be done to save the teeth? On the whole you will do well to go slow on sugar, keep your mouth as clean as possible, and have any cavities attended to promptly. But authorities tell us that in spite of the conscientious effort of the public to fight dental caries with the tooth brush and dentifrice, tooth destruction is as active as ever. An acrimonious discussion has long waged regarding the value of fluorine. As in the case with everything else in the human body, "just enough" gives excellent results. Overdoses of fluorine result in mottling

of the teeth. If there is a fluorine deficiency, then decay increases. The theory is as simple as that; the application is difficult.

Practically all our organs deteriorate with disuse, and the teeth are no exception. The increasing use of soft mushy foods requiring little use of our teeth is presumably a great factor

*Surgery among the ancient barbarians. An oral operation performed by a Scythian doctor. From a fourth century B. C. vase found in the Crimea.*

in their decay. However, with all their imperfections, they, or the store teeth with which many of us have replaced them, do a good job in preparing our food so that it may be in better shape for digestion.

## *The stomach*

The esophagus, or gullet, is a short tube from the mouth to the stomach. This latter thick-walled churn mixes up the food with the pepsin mentioned above, and with hydrochloric acid.

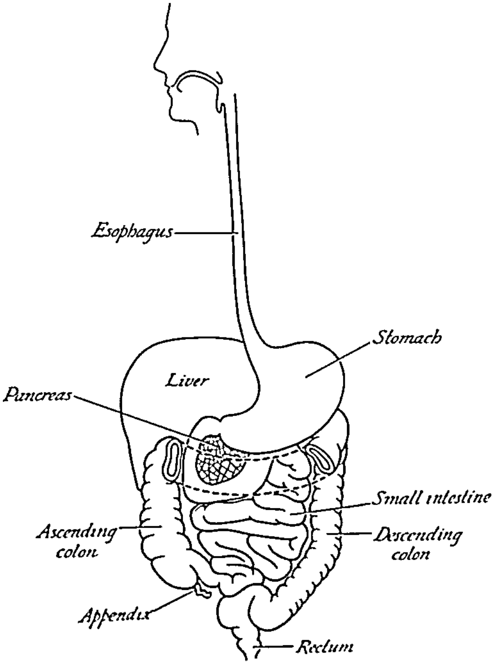
Pepsin will not work without it. If analysis of the stomach contents shows it to be absent, then look out. Two bad diseases, cancer of the stomach and pernicious anemia, are each associated with lack of hydrochloric acid.

I have called the stomach a churn. William Hunter said: "Some physiologists will have it that the stomach is a mill, others that it is a fermenting vat, others again that it is a stew pan; but in my view of the matter, it's neither a mill, a fermenting vat nor a stew pan; but a stomach, gentleman, is a stomach." It has become more and more evident in the two centuries since then that there is nothing like a stomach. Its mysteries are not unfolded yet, though we have a great deal of firsthand knowledge of what goes on in the stomach, obtained by direct observation.

Some years ago a group of us stopped at Mackinac Island where Lakes Huron and Michigan join. At that idyllic period of no autos, as we rode along behind a team of horses, I told the story of William Beaumont for which the island is famous. At the end of my tale, the driver turned with a grin, saying, "When there is a doctor in the group, my work is half done for me. I hold the reins; he gives the talk."

The first time in history that a man could look into the stomach of a living person was a dramatic stepping stone in medicine. William Beaumont, born in Connecticut, was an army surgeon at the frontier fort of Mackinac Island in the first quarter of the nineteenth century. One summer's day, a young trapper, Alexis St. Martin, was struck in the chest and abdomen by the discharge from a shotgun two feet away. It tore away some of his ribs, part of his diaphragm, and a portion of his stomach. His case, of course, was "hopeless"; but Dr. Beaumont did not proceed on that assumption and St. Martin survived the hardships of life in the wilderness, and got drunk at every opportunity until he was about eighty, when Beaumont had been dead thirty years.

The hole in the stomach never closed, so a contract was made. Dr. Beaumont gave St. Martin surgical care and supported him, and in return was allowed to make physiological studies. Thus he was able to describe the chemistry of the gastric juice, the movements of the stomach, and the appear-




General diagrammatic view of the digestive system. The transverse colon has been cut to show the duodenum (the beginning of the small intestine), but its course is indicated by dotted lines. (*After Cunningham*, Anatomy, *p. 1101. W. Wood & Co., 1903.*)

ance of its lining when the patient ate "pig's feet, wild goose, and venison." What is more, he noted the profound influence of the emotions. Even to this day most of our knowledge of stomach pathology comes from the studies of Beaumont. One of his pieces of wisdom is pertinent today. "The system requires much less than is generally supplied to it. . . . Dyspepsia is oftener the effect of overeating and overdrinking than of any other cause."

At the lower end of the stomach is the pylorus, a sphincter muscle, that is, a sort of puckering string. Every little while it relaxes, and lets some of the contents of the stomach into the duodenum. In this neighborhood occur most "stomach ulcers," to use the popular phrase. Physicians, when grouping them all together, speak of "peptic ulcers." Nearly all of them are duodenal. When a surgeon operates for a perforated ulcer, he locates the pyloric sphincter, a firm narrow raised band of tissue; and nine times out of ten, he will find the hole, if present, practically touching this, but on the duodenal side.

## *The small intestine*

From here on, there are twenty odd feet of small intestine, most remarkably arranged. All of its blood vessels, nerves, and some other structures come to it from the back wall of the abdomen through a thick sheet of tissue called the mesentery. It is attached to the wall for about six inches and then fans out. All of you must have seen a folding fan such as ladies carried to balls in the gay nineties so you can realize how there can be twenty feet of gut at the outer edge of the fan and six inches at the puckered end. But what a twisting of gut this makes. On picking up a piece of intestine it is difficult for anyone to tell whether that portion is a few inches from the stomach or the same distance from the large intestine at the other end.

We speak of the small intestine as consisting of the duodenum at the top, the jejunum next, and the ileum at the bottom. Surgeons can tell the first two apart by a little fold of mesentery at their junction but the second and third merge into each other as indefinitely as do violet, indigo, and blue in the rainbow. The small intestine handles the major portion of

digestion. Man can get along without his esophagus or his stomach, or his large intestine; but take away his small intestine and he is done for.

The bile from the liver and the gall bladder empties into the duodenum near its beginning, and at the same opening the pancreas contributes at least three kinds of digestive juices, which have been mentioned above. The lining of the intestine also furnishes a digestive fluid which is presumably a combination of a number of enzymes and is known as succus entericus. All these change the food so that it is ready to be carried to the body. That is digestion.

After fat is digested, the milky-appearing result is collected by small vessels, called because of this appearance lacteals, and goes into the thoracic duct. This vessel runs up through the chest and empties into a vein in the left side of the neck. All the rest of the digested material is taken by the blood through the portal system, and distributed to the liver. This portal system is a separate blood system and is not a part of the general system. It has been described further under circulation. It collects blood loaded with digested food from the intestine, and after running a very short course, discharges this blood into the liver. From then on, all the blood goes into the general circulation.

So far it would seem that the portal system was just an accessory to the digestive system. But man's physical body does not conform to, or furnish an inspiration for, his highly artificial tendency toward the complete specialization shown in his social organization. Many organs have two or more functions. As the bones not only form our supporting framework but are important as the seat of manufacture of blood cells; as the skin is a garment, a thermostat, and furnishes much of our sensation; as the pancreas digests our food and also regulates the sugar in the body; and so on ad infinitum; so the portal vein also carries blood from the spleen to the liver.

## *The spleen*

The spleen lies at the left upper part of the abdomen, touching the stomach, and protected by the lower ribs. It is said to

enlarge slightly after meals, and that is the only evidence that it has any connection with digestion. Since the portal vein is presumably extra busy at that time, one might see here an analogy to the five o'clock traffic congestion in our civic centers. At any rate the physiologists have determined that the spleen disposes of old, worn-out, or diseased red blood cells. It leaves the good, healthy cells alone. The tremendous spleens of sufferers from chronic malaria, in which disease the cells are filled with parasites, is a striking demonstration of this. Secondly, the spleen is a reservoir for red blood cells. The discovery of this fact is another example of serendipity, which is so common in medicine: the search for something of value, resulting in the finding of something else of even more worth.

Some physiologists had gone to the Andes to study mountain sickness, which occurs when the blood has difficulty in getting enough oxygen out of the thin air on the mountain heights. It makes no difference except to those whose love of adventure takes them to the Himalayas or to jobs with copper mining companies which carry them up the high Andes. But these investigators found that high altitudes increased the number of red cells in the blood. (Exercise does the same.) These demand more oxygen, and the more red blood cells that are circulating, the more oxygen is delivered. Following this up, they found that the spleen stores blood and lets it out into the general circulation as it is needed. Thirdly, some white blood cells are manufactured in the spleen.

So the spleen is a valuable organ but we certainly do not need it for digestion. Every little while a bad accident ruptures the spleen and, as it is a vascular (that is, bloody) organ, it is necessary to operate and remove it. Having once got over the operation, such patients do not miss their spleens at all.

## *The appendix*

Now that we have taken these side excursions from the main channel of the alimentary canal, we will again follow down its watery current. The terrible infections of the old days, such as cholera and typhoid, attacked the small intestine. I should say that on the whole it is fairly exempt from disease now.

Cancer, for instance which at present strikes all parts of the body, is not common in this portion. And we reach the large intestine and progress an inch or so before we meet the appendix, a nuisance to nearly all of us except the needy surgeons.

The appendix is possibly the best advertised organ in the body. Who does not know that appendicitis occurs down in the right lower portion of the abdomen? Unfortunately for amateur diagnosticians, there are many other things that occur right down there, such as small stones in the urinary passages, inflammation of the glands in that area, and a heap of others not worth listing. So it is a very wise idea to see a skilled physician when your suspicions are aroused. One of the most interesting aspects of appendicitis is that the beginning pain does not occur in this area but rather in the upper middle portion of the abdomen. Perhaps with the advent of the antibiotics, there is not so much appendicitis as there used to be; but it is still fairly common, and if a real good case occurs, there is no doubt in my mind that the best treatment is to have a surgeon take out the appendix pretty pronto. Once again you should be reminded that the worst thing to do in the case of appendicitis is to take a cathartic. That stirs things up in a very dangerous manner.

## *The large intestine*

The large intestine is only about one quarter as long as the small intestine, but it is much larger in circumference. Apparently the chief functions of the colon, to use its anatomical name, is to extract the water from the liquid discharge of the small intestine, and to store the resulting solid feces until a convenient time for a "bowel movement." But things are rarely as simple as that in the body, and the colon forms no exception. For instance, it is now known that the very important substance for blood formation, Vitamin $B_{12}$, occurs in enormous amounts in the large intestine of the cow, and is also in the human colon, presumably formed there.

The misuse of cathartics. No other part of the body has been so abused, because of the impression that it was just a sewer, and certainly a sewer should be freely emptied. Hence

the many sayings supposed to be so wise — "Trust in God, and keep your bowels open." "Keep your mouth shut and your bowels open." So the sale of laxatives runs into many millions yearly, and institutions like the "cipher list" of the hospital where I worked have caused trouble for the attendants and discomfort for the patients. Every afternoon the patients were queried as to their bowel movements. No movement, a cipher against his, or more particularly her, name. Possibly one, certainly two ciphers, produced efficient, that is, belly-griping, cathartics. The brilliant Dr. Sara Jordan, of Boston, having "reason to regard the colon with respect, even awe," quotes with approval from Chaucer:

> And I say furthermore
> That I ne set by laxatifs no store.
> For they be venomous, well know I it,
> I them defye, I love them never a bit.

I have known one medical man who claimed that he had got no cathartic in well over half a century. Another, in terror of his Scotch nurse, had a dose during the First World War, and has taken none since. A daily bowel movement is by no means a necessity. Plenty of water, some fruit and roughage, and patience when there is necessary delay would, if universally practiced, ruin the laxative trade.

> Hark, the herald angels sing,
> Beecham's pills are just the thing

and they made a tremendous English fortune.

Recently I got a letter from a seventy-year-old woman in which she complained that she had always been very constipated, and took a cathartic every night. Of couse she was constipated. There is nothing in the world more constipating than cathartics. They work by irritating the inside of the intestine, which then does its best to get rid of the irritating material. Chronic irritation always tends to toughen and thicken the part irritated. Notice the callus on hands which are constantly irritated by tools. Probably the inside of the woman's intestine is callused. Every authority on digestion argues against the use of cathartics. Nearly every doctor prescribes them almost routinely. Nearly everybody takes them whether

they are prescribed or not. So it is utter foolishness to argue against them. The word constipation in a patient's history usually means self-abuse with cathartics.

So much for the "constipated" well person. It is even tougher for the sick. For most patients the frequent appearance of the bedpan is exceedingly disagreeable. It is a psychological indignity; it entails much discomfort; it is inefficient and much more dangerous than people realize. The patient is not comforted to know that the personnel ministering to his needs share heartily his dislike. Nevertheless, it has been accepted as inevitable.

However, in recent years, there has been scientific study of bedpan procedures as compared with the use of the bedside commode. The energy expended can be measured accurately by the consumption of oxygen. Both heart cases and non-heart cases have been studied. In both groups it is found that it takes more energy to use the bedpan than the commode.

This is all very well but there are many cases who because of fractures put up in casts or slings, awkward wounds, etc., cannot be got out of bed. What's to be done about them? The answer should be: As every use of a bedpan is energy consuming, often to a dangerous point, and usually entails much discomfort, if not actual suffering, then the use of the bedpan should be as infrequent as possible. Nevertheless, that relic of barbarism, *the cipher list, is, I strongly suspect, still in use.* If the doctor is careless, one cipher may get by untreated; two ciphers almost certainly means cramp-producing Hinkle's pills, let the fractured bones wobble as they will.

Most hospital patients should require few bowel movements, for their inactivity and sickness destroy or reduce their desire for food. Their diet when taken is concentrated. They have little residue in their bowels. The lower bowel is designed as a reservoir. It should be allowed to act as such.

The violent and nasty purgatives of the old days have gone out of style now. Epsom salts are exceedingly bitter and disagreeable. They act chiefly by causing a copious flow of fluid from the tissues into the intestines and large watery evacuations result, giving the effect of a mild attack of cholera. Then there is castor oil, with a most sickening flavor. My father was

the only person I knew of who used castor oil in a sensible manner. When I was a boy, he gave me castor oil every Sunday afternoon. I took it and greased the axles of our light wagons. It is a most excellent lubricant on inanimate matter. I pride myself that never have I given it to a patient. The art of the modern pharmacist has made the swallowing of medicine fairly unobjectionable to the patient. Phenolphthalein is served as a rather inferior stick of chocolate. Liquid cascara may suggest prune juice, which I enjoy on my mountain trips. This is a far cry from the castor oil or dried pulverized toads of the old crude days.

The use of cathartics and other medicines for their effects on the alimentary canal is the most striking demonstration of the implicit faith of human beings that they may abuse their physiology to their heart's content if they will then take the proper medicine. Some philosopher has noted that man is the only animal that enjoys taking medicine.

Most of our dyspepsia or indigestion (You may take your choice: the first is Greek, the second Latin; they mean the same.) is simply the irritation due to too much food or drink. It is not disease, and medicine only adds insult to injury. Of course, a small proportion of cases is due to actual disease: ulcer of the duodenum, and ulcer or cancer of the stomach are examples. The first two of these may be helped to an extent by medicines. The third always requires surgery, and the others at times may require it.

## *Peristalsis*

The preceding pages have given you an abbreviated sketch of the anatomy and physiology of the alimentary canal and told a little bit about what happens to the food as it passes through. But how is it that the food moves along on a conveyor belt, as it were, getting more varied and skillful manipulations than a Ford car at the River Rouge plant? You must have surmised that it does not drop down by the force of gravity. A giraffe may get his food on the tree tops where gravity may take right hold and help him, but in a state of nature it is to be presumed that at water holes he gets this fluid at the

level of his feet. I will be frank and acknowledge that I have not watched this performance by a giraffe, but I did live to manhood in what, to most of you, were prehistoric days, and I have seen many a horse quench his thirst with his lips three feet below his stomach. The great gulps of water caused waves in the skin of his neck as they ran uphill, propelled by the powerful muscles of his esophagus, or gullet.

Man may do much the same thing at a mountain brook or spring, although, due to lack of practice, not so proficiently as the horse. But, as a matter of fact, because of all the twistings and turnings of the bowels, his food and drink have to move uphill almost as much as down. By straight line it is three or four feet from mouth to anus, but the food travels some *thirty feet; at least all that makes the through trip does.*

The force that carries it along comes from two sets of muscles, the circular and the longitudinal. These smooth involuntary muscles work without any control from their owners and in fact during health we are usually unaware of their activities. We start the food along by the swallowing muscles in our throat and then, when we are advised that it has completed its journey and the residue is ready for evacuation, we force it out by our abdominal muscles. Like any up-to-date factory, everything is automatic in between.

The action of the muscles of the intestines is known as peristalsis. When seen, it resembles nothing so much as the squirming of a bunch of worms. The circular muscles, as they contract, form the gut into a series of segments, pushing the contents back, thus churning and mixing them. The other set of muscles, which run in the long direction of the gut, are called longitudinal, and they cause a forward propulsion of the contents. A rippling appearance is obtained by the combined action of these two sets of muscles. When there is some intestinal obstruction in a thin-walled belly, the motion may sometimes be seen as it progresses under the surface and is referred to as a wave of peristalsis.

Peristalsis is not ordinarily heard but there can be much gurgling and squeaking when there is an unusual amount of gas in the intestines. You have all heard these "borborygmi" when you have had intestinal upsets. Some people seem to

have them almost normally, as witness the once popular limerick:

I went with the duchess to tea.
It was just as I knew it would be.
Her rumblings abdominal
Were really phenomenal,
And everyone thought it was me.

It had been always supposed that the gas was formed in the digestive tract by fermentation and putrefaction, but recently good evidence has been presented that it is practically all swallowed air. We are continually swallowing saliva and evidently take in much air in this way. Nervousness increases this habit. Before the automobile days one occasionally saw a "cribbing" horse, who would seize the manger by his front teeth and gulp down air. Human beings have this habit although their technique is different. Burping or belching is fairly common and whereas the burper thinks that he is emptying air from his stomach, he is in many, if not most, cases swallowing great gulps and letting a little up. Gas pains are due to the stretching of the intestines by gas, probably mostly air. When you stretch or pull the intestines, you get pain. They may be cut without any physical feeling.

## *The liver*

I guess that the average person if asked to draw a diagram of the digestive system would start confidently at the mouth, show a straight tube for the esophagus, a sort of water bottle effect for the stomach, and a much twisted set of coils for the intestines. All these make little bulk when empty and are only part of the picture. A large part of the size and weight of the digestive system are well to one side of this.

There are two large glands connected with the alimentary canal but lying entirely outside it, although they develop in the embryo from the wall of the small intestine. They are the liver and the pancreas. Each is in the upper abdomen, closely associated with the stomach; and each discharges, through a duct into the duodenum, its contribution to the digestive process. In fact, the two ducts have a common opening, the ampulla

level of his feet. I will be frank and acknowledge that I have not watched this performance by a giraffe, but I did live to manhood in what, to most of you, were prehistoric days, and I have seen many a horse quench his thirst with his lips three feet below his stomach. The great gulps of water caused waves in the skin of his neck as they ran uphill, propelled by the powerful muscles of his esophagus, or gullet.

Man may do much the same thing at a mountain brook or spring, although, due to lack of practice, not so proficiently as the horse. But, as a matter of fact, because of all the twistings and turnings of the bowels, his food and drink have to move uphill almost as much as down. By straight line it is three or four feet from mouth to anus, but the food travels some thirty feet; at least all that makes the through trip does.

The force that carries it along comes from two sets of muscles, the circular and the longitudinal. These smooth involuntary muscles work without any control from their owners and in fact during health we are usually unaware of their activities. We start the food along by the swallowing muscles in our throat and then, when we are advised that it has completed its journey and the residue is ready for evacuation, we force it out by our abdominal muscles. Like any up-to-date factory, everything is automatic in between.

The action of the muscles of the intestines is known as peristalsis. When seen, it resembles nothing so much as the squirming of a bunch of worms. The circular muscles, as they contract, form the gut into a series of segments, pushing the contents back, thus churning and mixing them. The other set of muscles, which run in the long direction of the gut, are called longitudinal, and they cause a forward propulsion of the contents. A rippling appearance is obtained by the combined action of these two sets of muscles. When there is some intestinal obstruction in a thin-walled belly, the motion may sometimes be seen as it progresses under the surface and is referred to as a wave of peristalsis.

Peristalsis is not ordinarily heard but there can be much gurgling and squeaking when there is an unusual amount of gas in the intestines. You have all heard these "borborygmi" when you have had intestinal upsets. Some people seem to

have them almost normally, as witness the once popular limerick:

> I went with the duchess to tea.
> It was just as I knew it would be.
> Her rumblings abdominal
> Were really phenomenal,
> And everyone thought it was me.

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of Vater. The ancients made anatomy easy for us by their picturesque names and eponyms. In this case a German named Vater described several centuries ago this opening as having the shape of a Roman wine jug (ampulla). It must be a rare physician who does not remember the ampulla of Vater.

The liver is a tremendous organ, the biggest in the body, weighing three or four pounds. It is difficult to be too eulogistic of such a great and versatile organ. Its importance is indicated by the fact that it has two blood supplies.

Blood comes to it from the aorta through the hepatic artery. It was mentioned earlier that a special blood system collects most of our digested food and carries it to the liver by the portal vein. Here it mixes freely with the blood from the hepatic artery. After the processing in the liver is finished, all the blood is then sent through a short vein back to the heart.

We are told that all the blood of the body goes through the liver several times in an hour. I know from experience that it is just soaked with blood and bleeds copiously whenever it is wounded. As it is connected with the heart by a short vein of large diameter, it follows that when a sick heart cannot handle the blood flow there is a backing up of blood into the liver which becomes swollen and soggy. We call it then a congested liver.

I could not begin to tell you all the functions of the liver. Here are a few that are well known. The sugar which when burned in the body furnishes most of our energy is somewhat changed by digestion and absorbed as dextrose (grape sugar). Then it is worked over by the liver into glycogen, or "animal starch," which apparently is quick burning. This is stored in various tissues of the body, but a goodly supply for emergency use is kept in the liver. Other food substances are also worked over here, and if we unfortunately take in some poison the liver does its best to destroy that. It prepares waste products from our food so that the kidney can excrete them. It produces a substance necessary for the forming of red blood cells. You are all aware of the miraculous effect of liver extract, or Vitamin $B_{12}$, on the previously unfortunate victims of pernicious anemia.

The most evident of the duties of the liver is the formation of bile. This is collected by a system of ducts or tubes and poured into the duodenum where it is necessary for digestion,

mostly, if not altogether, for the handling of fats. We are told that many animals, feeding only on plants, which certainly are not fatty foods, have no bile.

## *The gall bladder and related diseases*

The gall bladder, connected by a short side branch to the common bile duct, seems to be for emergency storage of bile. It holds only an ounce or two of this, and surgeons in thousands, if not millions, of cases have shown that it is not essential.

Among other materials, the bile has in solution various "salts." The chief of these is cholesterol. Under certain conditions, such as infection or slowing up of the bile flow, these salts may crystallize out and form gall stones. When their passage is blocked, severe "gall stone colic" may result and if the bile cannot get through, it is absorbed by the blood with resulting jaundice. Not all gall stones, however, produce these characteristic symptoms. Autopsies show many unsuspected cases. The best known to me is that of Dr. Samuel Johnson. Few men have had so many of the best physicians and surgeons of the day in consultation, and yet there is no evidence that his one large gall stone was suspected. He did complain much of "flatulence" which I gather meant distention of the stomach or intestines. We now remove many gall bladders for such symptoms. If you are a female, fair, fat, forty, with flatulence, you are a good candidate for a cholecystectomy (removal of the gall bladder).

Nowadays the diagnosis of gall stones or of inflammation of the gall bladder is easily one of our most accurate procedures. A quarter century or more ago a surgeon named Evarts Graham, instead of making dexterity with a knife his prime object, as army surgeons of those days did, went to work in the chemistry laboratory. He found that a certain compound of iodine, when taken into the system, was excreted into the bile. As iodine shows by x-ray, it could then be seen whether bile was filling the gall bladder. Also the presence of gall stones could often be determined. As perfected now it is a simple procedure, a triumph of teamwork between the X-ray specialist and the surgeon.

## *The pancreas*

The pancreas lies below and behind the stomach: a long narrow thing with its tail on the left side and its head over to the right near the liver. It secretes digestive juices which are poured out with the bile into the small intestine. These do a major part in preparing our three chief kinds of food, protein, carbohydrate, and fat, for absorption into the body.

But the pancreas leads a double life; no Jekyll and Hyde affair, but each existence most praiseworthy. Scattered through the great mass of cells which are secreting the digestive fluids are thousands of small groups of a different type of cell. These are the islands of Langerhans and from them goes directly into the blood the now familiar insulin, absolutely necessary for the burning of sugar in the body. This will be described more fully when the hormones are talked about. With the stomach not only aiding in digestion but also furnishing something that helps build blood, the liver with many, many functions, and the pancreas devoted equally to digesting food and supplying insulin to the blood, one finds plenty of evidence in the "pit of the stomach" that it is teamplay and rarely individual effort that makes the body efficient.

## *Diets and special diets*

This digestive system of ours is elaborate, as well as most efficient. It needs to be a complicated mechanism, in order to handle the many kinds of food that omnivorous man eats. But it is also amazingly adaptable, provided it receives the main necessary foodstuffs. It is geared to handle proteins, carbohydrates, and fats; and the varied diets that the more prosperous nations have eaten these last few hundred years have increased man's stature. This is easily demonstrated if one looks at the coats of armor worn by the medieval warriors.

The remarkable adaptability of our digestive apparatus is shown by the different kinds of food that certain races flourish on, by necessity. Stefannson notices that the Eskimos, who go without carbohydrates, are healthy and have the best teeth in the world; so he decides that meat is the ideal food. He

ignores the fact that these people have had a million years or so to adjust themselves. Other peoples manage to exist with practically no meat, they also through many generations having become habituated to it. Unless the old fellow fooled us again, George Bernard Shaw reached extreme old age on a vegetarian diet, but his scrawny frame might perhaps have better conformed with Isadora Duncan's had he enriched his diet.

Wild people lived on diets which to us seem queer, because they were forced to; they thrived on them when they could get them. Eskimos lived mostly on fish and seals. The Australian aborigines ate the queer animals which they had, and also moths and caterpillars. Neither race is doing well on our diet of white flour and sugar.

Our prejudices may guide us in our eating habits more than the actual value of the food. Not long ago I dined on the thickest, tenderest, most succulent rare steak that I had had in a long time. I had most kind hosts. The man beside me had a plate of beans, peas, carrots, and other, to me, extremely uninteresting vegetable viands. It was hard for me to realize that he had a nourishing diet. I am sure that he thought my steak at least revolting and probably harmful. Yet physically and mentally he is a big, virile fellow; and in my optimistic moments I think that I am doing well myself.

Throughout the ages there have been old wives' tales that certain foods were poisonous, or that certain combinations of foods were bad. There are a good many vegetables that cannot safely be taken into the alimentary canal of man. As far as I know there are few kinds of flesh that are poisonous. At a certain place on the Pacific Coast the mussels are sometimes dangerous because at those times the food which they collect from the water is dangerous. Many people think that a certain part of the lobster is poisonous. I have seen these parts collected from a number of lobsters and eaten with no resulting harm.

Undoubtedly some people have trouble with certain foods. Thus a friend got terrific swelling of his mouth and throat if he ate nuts, and some babies are in danger when they first eat egg, but these troubles are due to what we call allergies,

which will be taken up in a later chapter, and usually they can be gradually overcome.

Our diets are determined in many cases by our prejudices, formed with slight basis in fact, and we force our ideas on others. Dr. Wingate Johnson relates a story of the celebrated Dr. Janeway who, called in consultation, told the patient, "Eat all you want except creamed oysters." The puzzled general practitioner asked the eminent specialist how he realized that creamed oysters were contraindicated, and Dr. Janeway replied, "I ate some myself the week before and they damned near killed me." A somewhat similar case is that of an acquaintance of mine who, at a shore dinner, ate a few steamed clams and drank a great many highballs. The following day he was indisposed, but philosophically remarked, "It's my own fault. I always knew whiskey and clams did not mix."

These are individual attitudes. Custom may lead the population as a whole to take one-sided stands for or against certain articles of food. Not long ago a physician friend of mine got himself into hot water by saying that milk is an expensive food, as most of what one buys is water. Evidently he was just making a mild protest against the exalted position to which milk has been elevated by those enthusiasts who feel that one just cannot be really "hygienic" unless one drinks great quantities of milk. It is of course nourishing; the water, which is its chief component as to bulk, is excellent for one, and probably would not be drunk in such amounts by most people. But it is not a balanced diet and not infrequently is taken in large enough amounts to interfere with the taking of other good foods.

There are few universal rules about food, and yet food faddists are forever making and applying rules. Also special diets have been designed by physicians for special diseased conditions. The public does not always understand which is which. Certain diets have been so well exploited that they have received names. Thus there is the Hay diet and the Rice diet. I have had at times a slightly uncomfortable feeling that I was not quite sure which referred to the originator and which to the chief article of food. Millions of people live on a diet composed almost exclusively of rice. Don't you try it, unless a doctor decides that your kidneys are in poor shape. A hay diet

does not commit you, like Nebuchadnezzar, to eating grass, but there is no good physiological backing for it. It is not of great importance for you to know about these diets, for all special diets should be fitted to the patient, and not the patient to the diet. Any rigorous diet needs medical supervision.

There is no diet with a name that ought to have a blanket endorsement. For many reasons, many modern foods are too much refined but what you cannot get in one food you can get in another. If you will eat a little of all kinds of food, you will get the nourishment and vitamins and minerals which you need. It may safely be stated that for those who have not a disease a well-balanced diet is the best.

### *Is obesity a disease?*

According to Webster, disease is an alteration interrupting or disturbing the body's vital function; so obesity is a disease. Yet from time immemorial it has been treated as a joke to be fat. That attitude has changed. Try to take out life insurance and see the adverse attitude of those very practical businesses towards overweight. If your stomach girth measures more than your expanded chest, life insurance will cost you more, if allowed. The one situation where superfluous fat seems to be a decided advantage is in cold water swimming. Seals and whales take practical advantage of its great insulating quality.

A few years ago the *New England Journal of Medicine* published a symposium on obesity. With us doctors, a symposium means a collection of papers on one subject; the Greeks meant by it a drinking party. In this era of overuse of soft sweet drinks the Journal chose an excellent title. Dr. David P. Barr, professor of medicine at Cornell Medical School, let himself go when he discussed health and obesity. I will give you an extract, hoping that it does not drive you into self-enforced starvation.

> Obesity predisposes to diabetes, increases the tendency to hypertension, favors the development of atherosclerosis and contributes to heart failure. It increases the incidence of gall stones. It causes shortness of breath on exertion, intolerance to heat and excessive sweating. It leads to maceration, inter-

trigo, eczema and furunculosis. It fosters the development of postural emphysema, flat feet, hernia and osteoarthritis of the hips and knees.

If there are any words there which you do not understand, just take it for granted that they are undesirable bodily conditions. Dr. Barr said more, but it is just too tough for pleasant reading.

The mere carrying about of extra weight puts a decided handicap on the heart, causing inefficient mechanical functioning. It adds a burden to all the other muscles, the circulation, and respiration. The strain on ligaments and joints frequently results in chronic aches and pains, especially in the lower back and arches of the feet. The overweight, flat-footed policeman has been a byword for years. We do not see so many like him now.

Dr. Elliott P. Joslin, of Boston, long ago noted the relationship between diabetes and obesity and he has continued to stress it. Apparently overweight definitely predisposes to diabetes and when the disease is established, fatness complicates it, making the conduct of the case more difficult. One of the great dangers of the diabetic is acidosis. It used to be said that in the body the fat is burned in the flame of the carbohydrates. While this is not quite a true statement, yet the great trouble of the diabetic is the handling of carbohydrates (that is, sugar and starches). Burning the fat alone produces much partly burned, or oxidized, material that may cause diabetic coma, the most dreaded of complications.

Surgeons find their work complicated in fat people. A two- or three-inch incision is usually ample for an appendectomy and yet in a tremendously fat person a cut over a foot long has been known to be necessary.

Why do certain people have a tendency to become fat? Many agencies have been blamed, especially popular among the afflicted being internal secretions. Rarely can this be proved. When the whole matter is carefully studied, it is found that the thoughtful Dr. Samuel Johnson, two centuries ago, gave a pithy and correct answer: "Nay, sir, whatever be the quantity that a man eats, it is plain that if he is too fat he has eaten more than he should have done. One man may have a digestion that consumes food better than common; but it is certain that solidity is increased by putting something to it."

Many fat people say that they have inherited the condition. The answer to that is that if mother prides herself on setting a good table, if dad eats heartily, if the household attitude is that good food in generous quantities is the end and purpose of life, then the entire family may become obese, inheritance or no inheritance.

Visual education is being emphasized now, so look about you in the drugstores and lunch bars. Recently I found myself at noon in a suburb of New York. I was taken for lunch to what was obviously a popular place for mothers and children and the teen-age group. One could get a rather poor ham sandwich or the ubiquitous hamburger, but the staple foods which everybody had were cold sweet drinks and ice cream. These are good energy-producing materials and the young need plenty of energy, but they also need vitamins, minerals, proteins, and roughage, all of which should be supplied by their food; and here these things were at a minimum.

All of you have been exposed to much instruction on obesity. Books and articles on the subject have come in floods, all of them with an optimistic note, "Do this and become slim." Added to this are advertisements showing fat ladies who have become sylph-like and pointing out their royal roads to slenderness. Few if any of these procedures are of value. Exercise will not take off fat, but it will give you a wonderful appetite for more food. The athletes whom you see running with heavy sweaters on are taking off weight but it is water, not fat. Experimenters claim that the average man would need to climb the Washington Monument forty-eight times or walk sixty-six miles to burn up a pound of fat in the body. Neither do massage, vibrators, or straps influence the fat. Tight wearing apparel may make the bulges less conspicious, that is all. The bitter truth is that only diet will reduce your fat.

When fat people say, "Oh, doctor, I eat like a bird," one physician remarks, "Yes, like a vulture." This, however, is a little hard on the fat people. Their appetite is so good, having been developed when they were younger and could eat heavily without getting fat, that they really do not realize how much they consume. However, it is a sad truth that they cannot keep their weight down by physical medicine and gadgets.

All this does not mean that we should discourage the eating

of square meals. Active life requires proper nourishment. I will wager that Rocky Marciano eats enormous meals, yet I imagine that he goes in for thick steaks more than pies and pastries. You can be pretty certain that Joe Louis, in the latter part of his career when he was blubbery, did not choose his type of food carefully. Why, even in Great Britain, in the Spartan years of the war and just after, health authorities worried about obesity. You must remember that the scarce foods were proteins — meat, eggs, and cheese. The medical journals emphasized the social as well as the physical disadvantages of overweight, and spoke of young girls bulging with puppy fat that was derived from a free and unthinking flow of buns, sweets, and other carbohydrate foods. Fortunately, after puberty a girl's interests change, and her desire to be attractive leads automatically to wise eating.

The result of all this philosophizing about fat would seem to lead to the conclusion that it should be a simple matter to keep thin. A careful medical look-over of the great majority of obese people will show that there are no hidden physiological reasons to account for their being that way. Having made certain of this, the physician may then start the care of his patient with the confidence that the real problem is the control of the intake of food. First of all he must use judgment in deciding whether his patient does need reducing. Not all of us need to be the slender type. Youngsters at puberty may reasonably be a little plump. Some middle-age spread may be reasonable. After all, the Venus de Milo had more weight on her than would now win her the title of Miss America.

In recent years the psychiatrists have had much to say about the problems of weight control. They agree with the rest of us that fatness is the result of taking more nourishment than is needed, but they are trying to find out what impels one to do this. After all, there are few of us who would not prefer to have nice shapes if there were no bother or suffering necessary.

The psychiatrists tell us that much of this overeating is due to trouble in the minds of the patients. They are emotionally tense or they are trying to get away from situations which seem intolerable to them. Some are really mentally ill or are addicted to food as others are addicted to opium. One young woman, whose wavy light hair and peaches-and-cream complexion

made her nice to look at despite her embonpoint, told me that she had to cross to the other side of the street when she realized that she was approaching a candy store.

One untrained in psychiatry would suppose that a large proportion of fat people just like the taste of food and enjoy the sensation of having their bellies distended, and care little how they look and give little thought to the future. One wonders if such a bovine existence is a problem for the psychiatrist.

One sees numerous persons who have themselves decided that they could, unaided, bring their weight down and have succeeded happily. That is all to the good but those who have got the weight down only by making themselves miserable are very likely to backslide. A well-trained physician can usually handle the case without anguish to the patient and in general it is wise to call in his help. He will use some psychiatry, for it is recognized now that we are all a little bit queer and in treating any of our ills it is necessary to meet the situation.

It may well be that in psychiatric situations involving obesity other factors may be much more important than overweight. The cigarette-selling slogan of a few years ago was not a good general rule, as the tobacco company soon recognized and discontinued it. "Reach for a Lucky instead of a sweet" was not the proper prescription for lots of nervous girls. The rest cure for tuberculosis has to be carried through even though some of our friends come back from it looking far more pudgy than Psyche at her mirror. The mind plays a large part in the formation of duodenal ulcers, but the diet necessary for their treatment is a fattening one.

Rarely do you people who are carrying about too much avoirdupois need to go to specialists in mental diseases, but contrariwise, those of you with pleasing slenderness should view your plump friends with compassion. They may be bearing burdens on their minds on well as on their backs.

## *Ulcers*

Now it is recognized that the nervous system plays a great, if not dominant, part in the formation of ulcers. Fortunately, that truth was revealed to me long ago. Whenever I had a bout of indigestion, for good and sufficient reasons, I would

address my stomach thus: "I am the captain of my soul; the master of my alimentary canal. I am sending you corned beef and cabbage. You will take it and like it." I attribute to that firm attitude, and the fact that I gave up smoking, my freedom from peptic ulcers through all these years of stress and worry.

Nobody knows just why the ulcers develop. Everybody blames acid, but the stomach's work cannot be done without acid. However, cutting away a large part of the stomach from where it is known most of the acid comes has given pretty satisfactory results. This tremendous operation is usually a last resort after medical treatment has been given a good trial and has not worked well.

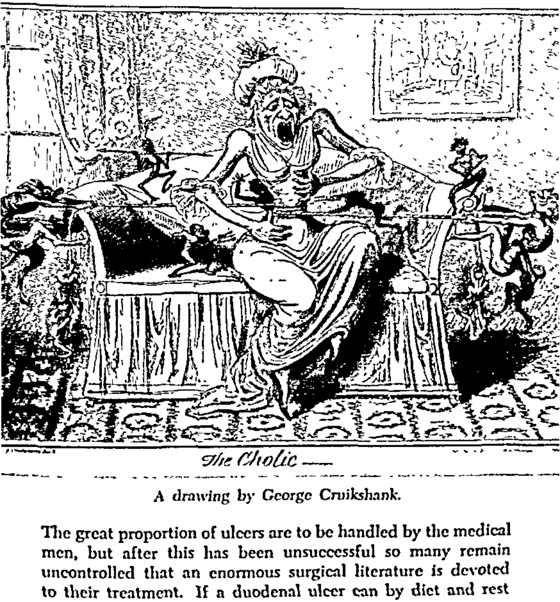
The nervous system is now recognized as largely involved in the ulcer problem. The late Dr. Harvey Cushing stressed the association between the brain and peptic ulcers. Nobody, though, has so far thought up any brain surgery for their relief. What might almost be considered as a step in this direction has been taken. The vagus nerve arises in the brain, runs through the neck and chest, and goes to the heart and stomach. In the modern operation called vagotomy the vagus is cut with resulting improvement to the ulcer. The ultimate value of this procedure will have to be decided after more experience.

One thing certain, however, is the effect of the emotions upon digestion. This has been proved even upon animals. The famous Russian scientist, Pavlov, who originated much of our knowledge of digestion found that he could make gastric juice flow in his dogs by the use of pleasant smells, sounds, etc. People with permanent openings into their stomachs have been watched and changes in the lining could actually be seen under the influence of emotions such as rage or fear.

So the feeling is growing that the problem of these ulcers is a part of psychosomatic medicine. This is a modern translation of the old phrase – the influence of mind over matter. Some people are naturally dyspeptic. They love cabbage but cabbage does not love them. When they are tired or worried or unhappy, it is their stomachs that kick up first. There appears to be a type of individual in whom the stomach is the chief organ of emotional expression and in whom ulcer is liable to occur. Whatever feelings they have way back in their "sub-

conscious mind" are expressed as a desire to be fed. The stomach then acts as it does in hunger, pouring out digestive juices.

Getting control of our emotions, especially when we are not aware that we have them, is more than most of us are capable of; so our only recourse is to have the resulting ulcers treated.



The Cholic —

A drawing by George Cruikshank.

The great proportion of ulcers are to be handled by the medical men, but after this has been unsuccessful so many remain uncontrolled that an enormous surgical literature is devoted to their treatment. If a duodenal ulcer can by diet and rest be kept from recurring, then medical care is satisfactory.

It is always to be remembered that ulcers actually in the stomach are an entirely different breed of cats. A duodenal

ulcer is not caused by cancer. But in quite a large number of cases an ulcer of the stomach will turn out to be cancerous. At the present time the only treatment of cancer of the stomach is surgical. It is safe to temporize with a duodenal ulcer. If a stomach ulcer does not quickly respond to medical treatment, the only safe procedure is to have it investigated surgically.

The alimentary canal has not been credited with being the seat of the emotions, although when we speak of hypochondriacs we are placing their troubles in the "pit of the stomach." Nevertheless this elaborate and most abused part of our anatomy has been shown here to be greatly influenced by our minds even though we are often not aware of it. What would seem more material and gross than the handling of our food supplies? Yet our minds may be dominant even here.

## RESPIRATION

The air which we breathe, the real, naturally clean air which lies upon the earth like a great atmospheric ocean and is not polluted to any extent except in the few small areas where men congregate in large numbers, consists of about 21 per cent oxygen and 78 per cent nitrogen. This latter is inert as far as we are concerned in breathing it. We cannot use it. (Its large amount is a striking commentary on man's belief that the earth was created especially for him.) Nitrogen has to be taken up by plants, where a series of chemical combinations occur before animals, including man, can use it in building up the protoplasm of the body.

The necessity and method of breathing must have been noticed very early in the history of man and yet its real significance and the nature and importance of oxygen to man were a mystery until the eighteenth century. Then Joseph Priestley, the Unitarian minister with great scientific curiosity, and practical ways of applying it, isolated oxygen. He did not know, though, what it was; but soon after him came one of the great chemists of all time, the Frenchman, Lavoisier. This man showed what the gas really was and named it oxygen. The contemporaries of these men showed their appreciation by burning

Priestley's house, and cutting off Lavoisier's head on the guillotine. The latter's widow married Benjamin Thompson, Count Rumford, one of the greatest of scientists, born in Woburn, Massachusetts. Science and its devotees have ignored international boundaries, as shown by these men — English, French, and American.

Most people think the object of breathing is to furnish oxygen to the body. Actually, it is fully as important to get rid of the carbon dioxide, carbonic acid gas, which results when waste tissues are burnt by the oxygen. That this carbon dioxide is a poison is shown when fishes are put into "soda water." They die even if there is plenty of oxygen in the water.

We see once again the cleverness of the body. It has to dispose of this poison, but it uses it first. The chief stimulant to respiration is carbon dioxide. Force a man to breathe hard and fast till the carbon dioxide of the body is exhausted and he may take no breath for a minute or two after. Such an experiment carried to an extreme may be startling.

Respiration starts when the child is born. Naturally he cannot breathe when he is entirely submerged in the uterine fluid. The chest is unexpanded and the lungs, which completely fill it, are empty of air. At the first gasp or cry, the muscles of the chest wall expand it, and the diaphragm, the great dome-shaped muscle between the chest and abdomen, pulls down. As there is no pressure inside the chest cavity, the outside air rushes in through the windpipe and fills millions of minute spaces in the lungs. At least it partially fills them, and within a few days practically completes the job. Throughout life the lungs are normally not completely filled or emptied with each respiration. That is one good reason for occasional deep breathing such as active exercise brings on. It tends to open up the farthest portions of the lungs.

The part of the air which the human body must have in ever continuing, prompt supply is the 21 per cent that is oxygen. Through the ages, however, our apparatus and our physiology have been adapted to handle oxygen only in this big dilution. You must remember that the action of this gas is that of combustion, burning. Therefore, strong oxygen is irritating to the tissues; our lungs will not stand it for long and after it is ab-

sorbed by the blood there is evidence that it may make trouble. So we start our breathing with a mixture or dilution of gases, and all the way down to the finest divisions of the lungs there is a continual stirring and mixing. From the nose down through the throat, windpipe and its main subdivisions there is a large space, holding air, and even heavy breathing does not remove

A wall-painting in Pompeii showing Aesculapius *(right)*, the Roman god of medicine, and his teacher Chiron the centaur *(center)*.

all this. Hence each breath mixes with air that has already been partly used. Neither are the lungs ever squeezed completely free of air. Finally, some of the remoter parts of the lungs usually remain collapsed and empty. Hence it has been estimated that the usual breathing takes in only one eighth of what can be inhaled and exhaled with deep breathing.

At first thought, this might seem a wasteful use of the energy necessary to pump fresh supplies of oxygen to us and an ineffi-

cient method of utilizing it. But it evidently has its advantages or necessity would have evolved a better method in a few million years.

If all the carbon dioxide were emptied at each breath, one might surmise that breathing would not be the smooth procedure which it ordinarily is. And certainly with this system the body does not have to live a hand-to-mouth (that is, improvident) existence as regards oxygen. A person can comfortably talk, laugh, or do many other things causing a cessation of breathing for a while with no discomfort. All my life I have enjoyed swimming under water and until very recently the snorkel has not been in existence. But long ago I learned a little trick which made it easy for me to take my time looking over the beauties of a sandy or pebbly bottom. Before plunging, I took a series of deep breaths. This did two things for me: it cleared out a lot of carbon dioxide, and at the same time gave me an extra supply of oxygen.

It has taken a long while to describe the course of this air from the atmosphere to the innermost recesses of the lungs. When it finally arrives, it is in a multitude of little chambers. In the wall of each are small blood vessels called capillaries, so fine that they barely allow blood corpuscles to squeeze through. These corpuscles or red blood cells are composed mostly of hemoglobin, an iron compound which carries oxygen from the lungs to the tissues and brings back the carbon dioxide. Just as the apparatus which carries the air in and out of the lungs never completely empties itself, so the hemoglobin never empties itself of oxygen or carbon dioxide. The body always works along at a gait much slower than it is capable of going. With extreme exertion the muscles sometimes use up oxygen many times faster than what we may consider normal. Then the blood is ready with the necessary reserves.

So far the talk has been about the two main gases handled by the lungs. There are many others which are also easily transported by the blood. Those which produce anesthesia are most conveniently introduced into the body by this route and are also so quickly eliminated that they are as a rule safer than those given in liquid form. At the opposite extreme is hydrocyanic gas, which when inhaled produces almost immediate

sorbed by the blood there is evidence that it may make trouble. So we start our breathing with a mixture or dilution of gases, and all the way down to the finest divisions of the lungs there is a continual stirring and mixing. From the nose down through the throat, windpipe and its main subdivisions there is a large space, holding air, and even heavy breathing does not remove

*A wall-painting in Pompeii showing Aesculapius (right),* the Roman god of medicine, and his teacher Chiron the centaur *(center).*

all this. Hence each breath mixes with air that has already been partly used. Neither are the lungs ever squeezed completely free of air. Finally, some of the remoter parts of the lungs usually remain collapsed and empty. Hence it has been estimated that the usual breathing takes in only one eighth of what can be inhaled and exhaled with deep breathing.

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death. Other materials are excreted by the lungs as your nose has at times told you.

Thus the lungs form an excretory organ, helping out the kidneys and the skin. They can in this way get rid of as much as a quart of water a day. Once again we have an example of a bodily organ, while performing one function, helps out in another. The whole interior surface of the respiratory tract has to be kept wet. Over and over you are reminded that all the functions of the body are performed only in a fluid medium. It has been said that the lungs absorb oxygen from the air. They do this through the moisture on the inner surface of the little chambers where the exchange takes place. It is just as necessary for the lungs to be kept moist as it is for the gills of a fish.

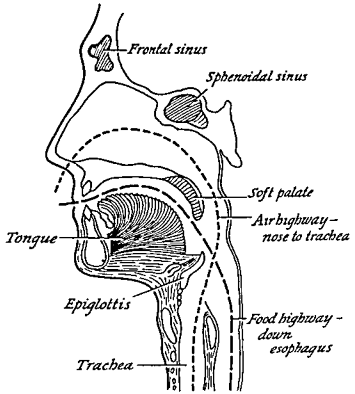
## *Artificial respiration*

So far this discussion has concerned itself with respiration which has been going steadily if not merrily on. Unfortunately, as you all know, it is not uncommon for breathing to be interfered with to the point where the breather can no longer keep it going himself. Then comes in the question of artificial respiration. You have all heard of mechanical devices for this purpose used by fire and police departments, but these are usually not quickly available, and time is of first importance; seconds count.

There is practically no hope of survival if a person has gone twelve minutes without breathing. But you must remember that it is often difficult to tell just when a drowning person disappeared. Also minutes may seem like hours in such a situation. The books on first aid give good instructions on artificial respiration. Inexperienced persons, however, are apt to be too vigorous and too fast in the maneuvers. The old-fashioned rolling on a barrel is a good method. When the patient is rolled towards his feet, a sagging down of the diaphragm results in inspiration; when rolled in the opposite direction, the weight then collapses the lungs, giving expiration.

## *Some respiratory organs have other functions*

Respiration, which next to the heart beat is our outstandingly vital function, is accomplished by apparatus most cleverly packed away, and accommodated to the surrounding organs, and, in fact, for a good portion of its extent not used for this sole purpose. Certainly smelling is done only by the nose, and although theoretically that is the part through which we




Cross-section through head and throat to show food and air passages and epiglotis. (*After H. E. Walter,* Biology of the Vertebrates, *p. 303. New York: Macmillan, 1939.*)

breathe, can you imagine any of our strenuous physical exercise carried on with the mouth closed to the passage of air? Our pharynx carries air, food and drink and helps to shape our voice. (I say "helps," for the contour of the mouth, the movements of the tongue, and the shape and position of the teeth,

also, as any music teacher will tell you, distinguish the good speaker or singer from the bad.) When we get to its lower portion there are two tubes leading on and most cleverly separating the air from the food. This is accomplished by a trap door at the top of the windpipe, called the epiglottis. A standard joke of the Victorian minstrel shows had the interlocutor explaining that the epiglottis moves forward and back separating the food from the drink and Mr. Bones making the obvious reply, "It must throw fits when we have bread and milk."

Actually, the epiglottis does not move but when we swallow, the windpipe rises and fits snugly against it. Watch somebody with a prominent Adam's apple (that is, larynx) the next time he swallows. Physicians take advantage of this fact when they are called on to decide if a tumor of the neck is a part of the thyroid gland, which is attached to the larynx, the upper part of the windpipe. The physician places his fingers on the tumor; as the patient swallows a sip of water, the thyroid rises, and he can see if the tumor moves with it. The adjustment between the windpipe and the epiglottis in breathing and swallowing is as delicate as a modern "electric eye." Otherwise our greediness or hurry would lead us to inhale food more often than we do.

The larynx is the upper portion of the trachea, enlarged and modified in shape. This is evidently not for convenience in breathing but to facilitate the chief method of communication with our fellows: that is, speech. A man's larynx is both longer and larger in diameter than a woman's; hence the deeper male voice.

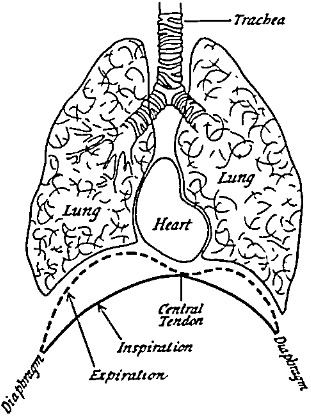
## *The trachea and bronchi*

From here on down the apparatus is devoted entirely to breathing. The trachea has a long series of stiff rings of cartilage as do the big bronchi, going one to each lung. These hold the lumen open all the time. The bronchi continue to subdivide in the familiar tree pattern, the finest ending each in a small hollow cell called an alveolus, or air sac. The industrious statistician who piles objects to the moon or strings

them around the equator has computed the combined inner surfaces of the alveoli as equal to a balloon ten feet in diameter.

## *The lungs*

The lungs have one main stem, the windpipe. They always act as one organ, but there are two lobes of the lung on the




Lower respiratory system. Solid line shows diaphram lowered to expand lungs—breathing in. Dotted line indicates position of diaphram when air is expelled.

left and three on the right. They are the most accommodating organs in the body. On lungs that have been hardened, the impressions of the heart, windpipe and other organs can be seen, showing how the lungs have made way for them.

They also accommodate themselves to human ways, which is, of course, their crowning achievement. As we are at the bottom of an ocean of air with a pressure of fifteen pounds to the square inch, naturally at birth air rushes down through the air passages, distending the lungs and chest. From that moment on until we die, breathing is automatic, or would be if the lungs were not so obliging. Whenever we wish it, they will, for a short period, vary the rate or depth of breathing or will even stop completely.

Since the lungs are attached on either side by just a stem or hilus where the main bronchus of that side, the pulmonary blood vessels, and nerves enter, it follows that they are freely movable. They are completely covered by a smooth moist membrane, called the pleura, which also lines the inner walls of the chest cavity. Hence they can slide easily up and down with each breath as they expand and contract.

The lungs are the least solid of the bodily organs, nearly all of their space being occupied by the hollow air tubes and the myriad alveoli, which are all filled with air. If lungs are healthy, a piece of them will float in water. Until recent times it has not been so easy to study real live, working lungs, for when the chest was opened, the atmospheric pressure became equal on the inside and outside and they collapsed. Modern anesthesia technique, however, can now maintain pressure within and keep them inflated to any desired extent.

## *Muscles used in breathing*

Inspiration is the active muscular part of breathing. When the muscles relax, the natural elasticity of the chest wall causes it to contract, forcing the air out. Then the muscles of the chest wall pull it open again. However, husky males use mostly the diaphragm and belly muscles to enlarge the chest space. In heavy breathing the belly muscles actually help to push the breath out. Hence we get the boisterous "belly laughs." Women use the chest muscles more and the diaphragm and belly less. I suppose that this has something to do with the question of pregnancy, as the enlarged uterus would leave little spare room in the abdomen.

### *The nose*

Despite the interesting and highly important jobs which the respiratory system does on the side, its one great function is to breathe air and it is very fussy about the quality of this air. This may sound queer to you who have so many experiences of the murky, smelly atmospheres where human beings congregate. The raw product handed to this system is often pretty bad but it has to take what it can get and go to work on it. It usually triumphs over its difficulties.

The entire extent of the respiratory system is wet. All the inside of the nose is lined with mucous membrane which normally is very wet. There are also several turbinate bones so placed that the air does not rush straight through but eddies about, absorbing moisture and warmth, before starting its journey to the lungs.

This air conditioning which the body carries on is a complex problem at best, and in the kind of life most of us live now, it requires many difficult adjustments. Most of the year outdoor air needs warming but little moistening. Then we step into our houses with atmospheres like kilns and immediately little warming, but great moistening, is necessary. The nose does a wonderful job of adjusting, but we are forcing on it just more than it can take. Then we hobnob closely with someone who has a cold in the head and we soon have one of our own to share with others. You can see for yourself that the stopped-up nose cannot do a good job of humidifying then. Many neurotic people refer their nervousness to their noses, and take nose drops or inhalants which give them pleasant feelings but usually leave some edema, that is, watery swelling of the tissues. The modern nose is often as much a nuisance as a convenience.

The air which is taken in through the nose not only has to be warmed and moistened, it also has to be cleaned. Under especially dirty conditions I have no doubt that you have demonstrated this latter when cleaning your nose or throat. But certainly in any city life dirt is continually coming in even if you do not notice it. From the nose, all along the respiratory system, down to the smaller bronchi, the tubes

are lined with small hairs. These hairs wave so that they push the dirt towards the mouth where it may be spat out or swallowed. Modern life is just too dirty, however, for these hairs to cope with it, and plenty of dust gets well down into the lungs. In fact, most dirt does not do a great deal of harm and some remains in the lungs during life.

Recently when reading a world-famous medical magazine I saw an editorial headed by the word aerosol. I must admit that I had always supposed this to be the copyrighted name of a preparation for killing mosquitoes and other insects. Actually it is a good dictionary word, meaning a suspension of particles in air or gas. We are told that it has been so prevalent in Los Angeles that the special name of smog was invented for it. Some years ago a number of deaths occurred in the Meuse Valley in Europe because of a heavy concentration of poisonous material in the atmosphere; and a few years later the same thing occurred in Donora, Pennsylvania. The London "particular" has been notorious for a century at least, and lately accurate records have shown that it has caused much sickness and death.

The worst conditions develop in this way: small particles of soot are suspended in the fog, and moisture condenses on them just as it does on your porch floor. This in itself is bad, for it keeps the smoke from dissipating. It is being shown more and more clearly that smoke is not good for the health and so large cities are taking steps to eliminate it. Yet on clear dry days smoke may be blown away fairly quickly. Cities along the sea coasts of the United States where fog is common should be especially concerned about the problem.

Smoke does not consist only of solid particles. There are always gases mixed in, and many gases from industrial plants are poisonous even in small amounts. They dissolve in the droplets of fog until they are in tremendous concentration. One gas commonly found in smoke is said to be in thousands of times greater strength in droplets of water than in the air.

If we breathe in gas, we may blow it out in the next breath or two. But the droplets are retained. If they are large, the nose may stop them and possibly great irritation results. If they are small, they may continue down and lodge in the

finest branches of the bronchi in the lungs. Rarely will conditions be such that many deaths will result, as in the Meuse and Donora, but these irritations may seriously affect persons already suffering from asthma, bronchitis, or tuberculosis. What can be done about this? Nothing much except to give encouragement and help to your Air Pollution Engineer.

**The nosebleed.** One thing that makes the nose frequently a nuisance is the familiar nosebleed. Who of you has not had at some time or other a nosebleed? And who of you has not had a favorite way of stopping it? "As many small boys know from experience, and others will learn soon, bleeding from the nose, as a rule, ceases spontaneously." This is the way an article from the Mayo Clinic started. Yet grownups are pretty apt to try to treat it and often in doing so prolong the bleeding. Simple means like putting a piece of ice on the nape of the neck are the best for a starter. This does no harm.

I well remember the case of a college boy with a severe nosebleed, which was treated by repeated washings. When, in desperation, I was finally sent for, the bathroom looked like a slaughterhouse. There was probably a cupful of blood and a bucket of water on the floor. This combination cannot be differentiated by the eye from pure blood. My treatment was to have him hold a towel to his nose for a few moments. He is now a grandfather and has had no more nosebleeds.

The most common cause of nosebleeds is picking the nose. I think that bleeding from this cause is almost never serious. Perforations through the septum, separating the two sides, and rarely a tumor inside the nose, may be more troublesome. About 10 per cent of the severe cases of nosebleeds are due to hereditary hemorrhagic teleangiectasia. This terrible-sounding name means simply that certain families are apt to have knots of blood vessels on the surface where any little damage produces severe bleeding.

The blood supply to the nose is a rich one. You see, man was originally designed to be outdoors a good deal and it was necessary to warm the cold air before it went to the lungs. The nose is lined with mucous membrane which is thin and most of it is up against unyielding bone. Hence the

blood vessels are easily injured. Scar tissue is thin here after repeated injuries, and so hemorrhages keep recurring.

Recurring bleeding from spots such as we have described is often stopped permanently by cauterizing the area, thus destroying the blood vessels locally. The usual emergency treatment for bleeding which is really causing the loss of a dangerous amount of blood is to pack the nose with gauze. This is a skillful job, for merely stuffing the front of the nostrils will probably not stop the flow but will divert it into the throat. Fortunately elaborate procedures are rarely necessary. Nine hundred and ninety-nine cases out of a thousand will soon stop if you will press on your nostrils and wait.

## *The "common cold"*

Far and away the greatest source of trouble to the respiratory tract is the "common cold." I do not know when or how this name originated for certainly people have colds in hot weather. However, we can date it back as far as Shakespeare, one of whose characters, sharing my feelings, says, "I have a whoreson cold."

St. Kilda is off the west coast of Scotland, the outermost of all the islands. It is such an exposed, rough place that for centuries strangers could land there during only the three summer months, and a few years ago the government moved all the inhabitants to the mainland.

In 1698 a man named Martin managed to get there and wrote an account of his visit. He made two observations on the health of the natives. "They generally have good voices and sound lungs; to this the Solan-goose egg supped raw doth not a little contribute; they are seldom troubled with a cough, except at the steward's landing. . . . I told them plainly that I thought all this notion of infection was but a mere fancy. . . . It was remarkable that after this infective cough was over, we strangers and the inhabitants of St. Kilda, making up the number of about two hundred and fifty, though we had frequently assembled upon the occasion of divine service, yet neither young or old among us did so much as once cough more."

Sixty odd years later the Reverend Mr. Macauley visited

there. "When I landed all the inhabitants enjoyed perfect health. . . . On the third day after I landed, some of the inhabitants discovered evident symptoms of a severe cold, such as hoarseness, coughing, discharging of phlegm, etc., and in eight days they were all infected."

Now this was a good two centuries ago when people were a great deal more ignorant than you are now. These people did not have any overshoes or rubbers or central heating and they lived in poor draughty houses in one of the worst climates imaginable. Solan-geese feed entirely upon fish and you can imagine what their eggs tasted like. No wonder, with their belief in nauseous medicines, they thought it was the vile-tasting Solan-geese eggs that kept them from the common cold, at least until the proprietor's steward arrived from the mainland in the summer. People in those days did not know that there were such things as bacteria and viruses.

Since those days many cases similar to that of St. Kilda have been studied. Longyear City is a coal mining town on Spitzbergen, way up in the Arctic Circle, which is isolated for all except a few months of the year. Though exposed to a rigorous climate the inhabitants are free from colds, but, "after the arrival of the first boat . . . an epidemic of colds followed with explosive onset."

Economically the common cold is no mean problem, as is recognized by such eminently practical organizations as the great insurance companies. The Metropolitan Life Insurance Company has been considering this problem and their conclusion is that colds cost the country one billion dollars a year. They didn't just guess at this figure. They studied the reports of reliable investigators who had collected data from groups of students, wage earners, etc., who could be carefully studied. They found that the average person had at least two colds a year. I think many of you will be surprised that the figure isn't larger. In the whole United States of America this foots up to three hundred million cases, and as the trouble usually lasts five days you can see there is an awful lot of time lost when jobs are not being done efficiently. Absenteeism from this cause is enormous, having been figured at sixty million days a year.

Now according to my ideas there are no drugs in the world that are any good for treating colds, as far as curing or shortening the disease are concerned. However, most of you do not believe this. You listen credulously to what is told you over the radio, and it is said that you spend about four hundred million dollars for a year's treatment. The enormous figures given for the country's bill do not include the cost to the employers.

The Britishers, who go doggedly at things, have been conducting a tremendous research on a windswept hilltop just outside Salisbury in southern England. This may sound foolish to you who know how you catch your colds and have learned from advertising campaigns how to cure them, but, although almost everyone has his own foolproof technique for preventing or curing colds, yet colds are as numerous and as troublesome as ever. The Salisbury investigators have experimented with over fifteen hundred volunteers. They pay the traveling expenses, give free board and lodging and a little pocket money. In this way they get an intelligent, cooperative group, mostly university students. The last I knew, the project had been going on for several years, and the experimenters still believed that colds are caused by a virus or viruses.

These human guinea pigs are carefully isolated for four days to make sure they are not developing colds, which usually occur in from two to three days after exposure. Then they have material placed in their noses. This may be simple broth, egg white, or what have you. In no case does the patient or observer know what has been used. Then many careful observations are made. About 60 per cent of those who actually get infected material respond with colds.

The British scientists think that catching a cold in real life depends on receiving quite a small dose of virus at a time when one's defenses are momentarily off guard. If this were not so, we would always be having colds, for one of their experiments was putting fluorescein in the nose of a patient with coryza (dictionary name for a common cold). The most minute amount of this can be seen under ultraviolet light and they found it everywhere the patient had been: on hands, face, all over the room, even on the food. Now won't you, please, when

you have a cold, stay at home, and not spread your contamination all over town.

One experiment tried at Salisbury was to chill the subjects thoroughly. The latter were soaked in hot baths and then stood about undried in a cold passage as long as they could stand it. In addition the poor unfortunates wore wet socks for some hours. Chilling alone produced no colds. I knew it wouldn't. I have tried the same experiment on myself thousands of times.

However, chilling plus the virus produced more colds than the virus alone in people kept warm and comfortable. That is what was found at first, and this agrees with the preconceived ideas of everybody. *The bane of investigators is preconceived* ideas. These people avoided them and as they said, "We were foolish enough to repeat the experiment." This time, those with the virus alone had twice as many colds as those with the virus plus chilling. There is no good evidence that chilling is the wicked thing that you all think it is.

I realize that there is little in the above that is really believed by run-of-the-mill people, including most of my doctor friends. But this is the first experiment, carried out on a large scale of such a careful nature, that I know of. To my mind it shows that the only factor of importance is infection. *Eliminate* that and "colds" will not amount to much.

One thing that is particularly disturbing to people with colds is the extra secretion of "mucus." This is a well-known word. I think you all use it glibly and you mean by it a very disagreeable substance. However, in discussing the digestive system, I mentioned that there is a secretion of mucus all along its extent, and at the upper portion the digestive tract and the respiratory tract are one and the same. This mucus, put there to lubricate and protect, naturally responds to emergency calls, and colds undoubtedly furnish most of these emergencies. Then we get an over-secretion of mucus. The body can't always regulate furnishing just enough and not too much. The mucus secretion that goes with a cold is a nuisance, but you have got to be philosophical about it. The body's intention is a right one.

### *Cough*

The upper respiratory system attempts to get out of our lungs the material that ought to come out. Unfortunately it does not always do a complete job. Then our great ally is a cough. Much as we dislike a cough, it is not wished upon us for our sins. It is intended for our protection. We accomplish it by taking a breath, closing off the top of the windpipe with our muscles and then squeezing hard with our chest muscles and belly. As the top of the windpipe opens suddenly, the air rushes out with an explosion and may carry the offending matter with it.

Cough can be voluntary or involuntary; that is, we can cough when we wish and we often cough because we cannot help it. Most coughs are somewhere in between this. But any cough that persists should be investigated because it is frequently a symptom of serious trouble.

The careful physician can find signs from head to feet which might give insight into the cause of the cough. Some of them might surprise you. A physician friend of mine told of four cases of chronic cough with which he had had experience, all caused by hairs in the ear canal, pressing on the eardrum. This may not at first hand sound reasonable to you but you must know that the heart, lungs, and stomach are controlled largely by the tenth cranial, or vagus, nerve. Branches of this nerve also go to the larynx and eardrum. So if you have trouble in your ear or your vocal cords or have an irritated stomach, any one of these may set you coughing.

It is the irritation of the nerve endings by any of these things that results in coughing, and unfortunately men and women find many things in modern life to irritate them, even though they cannot cough them up. Probably the cigarette cough leads all the others for it goes on continually, while all of us have some respite from the common cold, in which the droppings from the back of the nose are a nuisance. All radio listeners are aware of the outbursts of coughing which come when there is a pause in a symphony concert, for much coughing is just due to nervousness. So buy your cough medicines if you must, but,

if the cough persists, you will be smart to try to find out what it is all about.

## *Whooping cough*

Grown up as you are, you may even have whooping cough. This is one of the diseases which, like shingles, is often referred to in a joking way and yet actually is very far from a joke. It is in most cases a childhood disease for it is so contagious that few children escape it. The Bordet-Gengou bacillus, named after the scientists who identified it, has been definitely incriminated. The scientific name for the disease is pertussis, which after all is just Latin for a bad cough.

Newborn babies seem to have immunity against a good many infections, but not to whooping cough. It is most common between four and eight years of age. Because in its early stages it appears like any cough, and thanks to the prevalence of head colds, laryngitis, and bronchitis, nearly everybody has a cough in the spring and early summer, the disease is not recognized until it has been passed freely around. Hence epidemics.

When the infection is well developed there is a sticky, thick secretion in the windpipe and its branches in the lungs. This irritates and tickles so that children go into paroxysms of severe coughing so steadily that they cannot get their breath. Finally when they are blue in the face with choking, they draw in a deep breath with such force that it causes the characteristic sound of the whoop. Frequently this will loosen a great deal of the secretion, which while being coughed up often results in gagging and vomiting. There may be a few weeks of these procedures. The vomiting and accompanying starvation may cause the loss of a lot of the fluids and salts of the body, with a condition which physicians call alkalosis but which the public, aided by patent medicine advertisements, are much more apt to call acidosis.

The younger the patient, the more serious the disease. Broncho-pneumonia is often associated with it and is the gravest danger. Therefore pediatricians give whooping cough vaccine as a preventative very early in life. Certainly do not expose untreated youngsters to the disease if it can be helped.

## *Pneumonia*

Pneumonia is the accepted name for pneumonitis, or inflammation of the lungs. Every textbook article starts by telling us that Hippocrates was familiar with it. Yet from his day until the last decade or so little was added to our knowledge of it except a lot of technical details of interest only to trained students of disease. As a matter of fact, I have just read the latest, highly esteemed textbook of medicine and also Sir William Osler's *Practice of Medicine,* written a half century ago; that is, I have read their articles on pneumonia. In my estimation Osler had far the better story except that he was just too early for X-ray examinations, and as for treatment, he could say only this: "Pneumonia is a self-limited disease which can neither be aborted nor cut short by any known means at our command."

John Bunyan, in his *Pilgrim's Progress,* spoke of consumption as "Captain of the Men of Death," and over two centuries later Osler decided that pneumonia then merited the name. It was a little difficult to say just how important it was as a fatal scourge, for many a long drawn-out chronic disease was finally mercifully ended by an acute attack of pneumonia, when the patient had become too weak to aerate the lungs and keep them healthy. For this reason Osler called it "The Friend of the Aged."

It is agreed that pneumonia is caused by infective organisms, of which the most common is the pneumococcus, but numerous others are found guilty at times and some of them are especially wicked. In the great, widespread influenza epidemic towards the end of World War I, people were dying like flies, often it would seem, of streptococcus pneumonia. Nowadays we hear much of a particularly miserable virus pneumonia.

The pneumococcus is not a scarce organism; it can be found in many places in the body, especially in the nose and throat secretions, but it does not at all follow that the patient is sick. It would seem that the germ lurks about, and when it finds conditions just to its liking, it seizes the victim. Neither does it follow that the patient has to be weak, puny, or ailing to succumb. Husky young athletes, apparently in the pink of

condition, may be struck down. Cold has always been regarded as a cause but Montreal is a very cold city in winter and Osler

Dr. William Osler (1849–1919), before he became Sir William, Bart. Regius Professor at Oxford; also Saint of Johns Hopkins. An excellent portrait despite his unusual situation.

reported that in January, the coldest month of the year, there was a comparatively low death rate from pneumonia. In the late winter and early spring of 1917 a thousand wounded might

be admitted to our big hospital in a night. I wore all the clothes that I could pile on me and felt congealed. Yet the wounded boys were not very warmly clad, particularly the Scotch with their bare thighs, and they had been exposed to cold and wet for long, long periods. If cold and exposure were great factors in pneumonia, there should have been epidemics then, but there were none.

There was one aspect of the pneumonia of the old days that was a great source of elation to the physician and family and yet it was also at times a frustration to the former. This was the spectacular "crisis." Many diseases, typhoid for instance, get well very slowly and gradually. Not so with the characteristic recovery of pneumonia. The patient might appear desperately sick, with high fever and prostration. Then, usually in five to twelve hours, but often in an hour, the fever would drop many degrees, the respiration return almost to normal, the pulse would slow, and the patient would pass from a state of extreme hazard and distress to one of safety and comfort. There was a belief among physicians that these crises occurred on the odd days, as the third, fifth, or seventh.

Now why should there have been any frustration about such a delightful phenomenon? The best physicians have always been chary about using the word "cure." As they knew that there was no good treatment for pneumonia, they relied only on good care. My friend, Dr. Frank Fulton, as he was making morning rounds with the intern, was shown a man, exceedingly sick with pneumonia. He studied him carefully and then resignedly remarked, "Well, the best thing we can do for him is to put him to bed with a good nurse." But in the minds of many people there is always a cure. The question is where to find it. A family may be told by a kind neighbor of a similar case miraculously cured by a cultist. The family, in desperation, might then dismiss the doctor and call in the wonder worker. If the crisis occurred a day or so later, could that family ever be convinced that the sick man did not owe his life to their wisdom in switching? They could not.

All that, however, is ancient medical history. The sulfa drugs came along in the 1930's and made life hard for a lot of pathogenic bacteria. That is what we call those which attack

our health. (The others, most of which are trying to help us, are called saprophytic.) Then came Armageddon, just before the Second World War, and penicillin has made pneumonia a weak warrior. Do not think, though, that it is completely out of the picture. The forces of evil never give up the battle and organisms other than the pneumococcus are still bitterly attacking the lungs.

**The examination of the lungs.** The art of examining the lungs has been used as long as there has been any real medicine and in recent years it has come pretty close to being a science. Until the last half century or so the only good methods that we had were percussion and auscultation. These are perfectly good Webster's dictionary words, meaning striking and listening. Like the players of pianos, drums, and cymbals, we strike to produce a sound. Like persons striking partially filled barrels or carpenters pounding on plaster walls to locate concealed beams, we judge from the pitch produced whether we are striking over air or fluid or solid material. In pleurisy there may be fluid in the chest cavity. With pneumonia the affected part of the lung may become solid as liver, so we speak of the condition as hepatization.

*The stethoscope.* We share percussion with the symphony orchestras. The word auscultation we have almost entirely ursurped, thanks to the brilliancy of a most poetically named member of our profession. Many a person with a humdrum name has wished for a more picturesque one and not a few have helped themselves to better. A century and a half ago a French family bestowed upon their fortunate son the exquisite title of René-Théophile-Hyacinthe-Laënnec. So far as I know he was never, despite this, a poet, but he was a great helper in the science of medicine. Several important diseased conditions were first described by him, but his great contribution was a new method of determining the faint sounds produced within the chest. He invented the stethoscope.

When a cartoonist wishes to picture a physician, he equips him with either a head mirror or a stethoscope. As a matter of fact, the former is pretty awkward for us who are not nose and throat specialists. But we all use stethescopes. The principle is simple. Hearing is the effect produced on the ear by air waves

from a vibrating object. It has long been realized that these waves can be directed or steered. For instance, in St. Paul's Cathedral in London, one can whisper gently against the inside wall of the dome and the sound will be heard by a person holding the ear to the opposite wall a long distance away.

While Laënnec was out walking one day, he saw some children playing about a long pipe lying upon the ground. The child at one end would whisper gently and the one at the other end could hear clearly. It occurred to Laënnec that the scheme might work in listening to chests so he went home, rolled a piece of paper into a cylinder, one end of which he placed against his patient's chest. It worked. He then made a hollow wooden tube. Now we have elaborate instruments with well-fitting ear pieces, flexible rubber tubing, and a bell or vibrating disk at the other end.

This is still a valuable machine despite the jokes that doctors make about it and their fellow medical men who use it. The Mayo brothers used to say that their doctors carried stomach tubes hung around their necks instead of stethoscopes. I have been told that Dr. Merrill C. Sosman, of the Peter Bent Brigham Hospital in Boston, who knows that his X-ray will show some fine changes in the lungs that cannot be located by a stethoscope, has a framed stethoscope, on the wall of his office, labeled: "Obsolete instrument formerly much used by internists." But the internist cannot carry an X-ray machine hanging about his neck. He can quickly learn a lot with René Hyacinthe's handy little gadget. Later he may supplement this with the X-ray.

Some of you may remember using crystal radio sets. To my mind, what you did hear over them had a clearer, more perfect note than what you often hear over expensive modern machines. Old-time medical practitioners thus compared the naked ear and the stethoscope. In our town, about the time when I commenced practice, there was a highly esteemed, elderly physician who when the stethoscope sounds did not quite satisfy him, would put his ear directly on the patient's chest. One evening, after an unusually tiring day, he got an emergency call. Reluctantly he took his bag and trudged off, as he knew that his horse was also tired. The patient was a

delicate young lady with a cough. With his stethoscope he listened long and carefully to her chest, but could not satisfy himself as to what he heard. Telling the maiden of the occasional advantage of listening with the naked ear, he abandoned his scope, placed his head upon her breast and again listened long and carefully. The patient finally became more and more restless, until, glancing down she saw that the old gentleman was sound asleep. So, put your calls in early, if you can. Don't overwork a willing horse — or a willing doctor.

*The X-ray.* The stethoscope is still the constant companion of the internist, but we have other methods that undoubtedly go beyond it. I think that every medical man will agree that the chief of these is the X-ray. I trust that all of you know that it does not "take pictures" but throws shadows on a plate or film. Substances vary in the amount of shadow they cast. The rays go unimpeded through air. The heavy heart muscle throws a deep shadow, and a lead slug in the lungs would let no rays through. There are all gradations, and the skill of the roentgenologist now seems marvelous to us whose accomplishments are more highly developed along other lines. Not only are the shadows of the tissues studied by X-rays but "contrast media" are also used. These are substances which show heavy shadows when they are introduced into the body. They are probably more familiar to you when used to outline the stomach, intestines, gall bladder, kidneys, and even the blood vessels. They are introduced into the lungs by spraying them down the windpipe and they are then breathed into the deep recesses. If the bronchi are misshapen, plugged or end in large dilations, the outlines will be shown on the X-ray films. After giving all these commendations to X-rays, I feel it only fair to say that an X-ray friend today told me that the man with the stethoscope and the percussing finger can study certain things better than he and his X-ray machine.

*The Bronchoscope.* But, if X-ray, like a shadow, proves the substance true, there are many who want to see the thing itself before they are convinced. This is now frequently accomplished, even in the recently inaccessible middle of the lungs. An instrument that is fearful to contemplate by one who is a candidate for its use, the bronchoscope, is, in clever

hands, great for investigation as well as treatment. It is a rigid metal tube, about a foot long and large enough in caliber to hold a light and instruments with which the operator may perform innumerable cuttings and manipulating. Of necessity this tube must be straight. If you will study the anatomy of the head, neck, and chest of one of your acquaintances, I think you will be convinced that there is no straight line through the respiratory canal for this tube. But there is. The head has to be bent back more than one normally cares to hold it but once one resigns oneself to a physician's bothersome ways his accomplishments may be surprising.

I imagine that the bronochoscope was developed originally for removing from the windpipe and large bronchi the peanuts, safety pins, and divers other things which children inhale. The removal of misplaced objects is no longer, however, the chief work of a bronchoscopist. His main concern is with the investigation and treatment of diseases of the lungs and bronchi. Lung abscesses can be helpfully studied. Tumors of the lungs are now recognized as common and the majority are connected with the bronchi; they can be studied by direct vision, a piece removed for examination, or sometimes a whole tumor can be thus removed.

Tuberculosis of the lung is today treated, in many cases, by collapsing the lung in one of several ways. Before this is done, an examination is made with the bronchoscope to be sure that a bronchus is not blocked, which would interfere with its collapse.

## *Tuberculosis*

The decline in incidence of tuberculosis in the United States has been tremendous since about 1900. The death rate was five times as great then as it is fifty years later. When I was an intern, the children's ward was pretty well filled with the victims of bone tuberculosis. Nowadays I think that it is mostly confined to the lungs. There is reason to believe that the incidence is still decreasing, but it is far from disappearing. Ignorance and poverty are always contributing factors; early diagnosis and improved treatment undoubtedly are helping us.

There is only one way by which it is spread and that is by contact. If you do not go near tuberculosis, you will not get it, no matter what your way of life is. But it is one thing to tell you to stay away from it and another to accomplish this. Statements as to the amount of it around are truly startling at first. It is said authoritatively that about 50 per cent of the population of the United States have been infected with the tubercle bacillus. But there is a bright ray of light shining through this gloom. Even if we belong to the infected 50 per cent we probably have a considerable degree of immunity. We have our tubercle bacilli encased in calcium as a hen's egg is encased in the calcium shell.

When primitive people like the Eskimos or South Sea Islanders were attacked by tuberculosis or syphilis or even measles they died like flies. Although we do not thrive on some of these diseases, nevertheless we stand them fairly well. The theory is that many of our distant ancestors had these diseases and those who survived to become our more immediate ancestors gradually accumulated considerable immunity to them. So we do not just give up the ghost when we get tuberculosis. If it lands in our lungs, we may develop a small patch of pneumonia and perhaps kill off the bacilli. Failing this, our blood cells gather round and form tough tissue and then a condition known as caseation occurs, so-called because it resembles cheese formed from casein. Later on the firm calcium case mentioned above occurs. The modern scheme of X-raying almost everybody in the community shows that a large proportion of us have gone through this program and are doing well. The intensive campaign waged against tuberculosis for a half century or so has accomplished a great deal.

### *Lung cancer and cigarette smoking*

No discussion of respiration would be complete without considering the relationship of lung cancer and cigarette smoking. This modern world is a world of marvels. It is not a great exaggeration to class among these marvels the increase in cigarette smoking in the last half century or so.

It is surprising that cigarettes have the widespread popu-

larity which they do. In themselves they are distasteful to a non-smoker. The habit must be acquired. A natural repugnance to the aroma and the initial vertiginous and nauseating effects have to be overcome. In spite of this, each new generation cannot wait to sneak a smoke behind the barn, under stairs, or in the privy.

Cigarette smoking was certainly in poor repute in the 1890's. A real "he-man" smoked a pipe, or a cigar, or chewed tobacco. One could not imagine a truck driver with a cigarette dangling from his lips. To the public at large, a typical male cigarette smoker was an effeminate type of fellow. As for the women, few of them smoked unless they were of a low social grade or were wicked. There is no need to tell you of the present picture.

None of the great industries realized more quickly or thoroughly the absolutely irresistible power of advertising and publicity than did the tobacco manufacturers. They had increased cigarette smoking very materially before the First World War, when there was a tremendous upsurge. It was almost as important to get cigarettes to the AEF as it was to get ammunition, and from then on the flood has been, until recently, uncontrollable.

Then something dire happened — we are speaking now from the point of view of the cigarette industry. Anesthesia and surgical techniques developed so that the interior of the chest began to be examined more and more, and with the cooperation of the pathologists it was soon realized that cancer of the lung, instead of being a rare condition, is a common one. Naturally, this situation was inquired into. As everybody knew, cigarette smoking and coughing were associated, and it was not long before lung conditions and smoking were examined statistically. Dr. Evarts A. Graham, of St. Louis, who was a pioneer in surgery of lung cancer, was soon impressed by the relationship, and early issued a report that there seems to be here a case of cause and effect.

It is well known now that smoking has an adverse effect upon the blood vessels. There is no doubt that heavy smoking is bad for the nervous system. Plenty of my fellow-physicians have told me how it affected them when they overindulged.

There is a vicious circle here: cigarette smoking makes people nervous; nervousness makes people smoke more cigarettes. A large part of cigarette smoking is simply a nervous reaction, much like thumb-sucking with children. In fact, psychiatrists have advanced the argument that sucking a cigarette and sucking a thumb are one and the same subconscious reaction.

To add to the list of serious organic diseases significantly related to cigarette smoking, we can now add cancer of the lung. There is direct and conclusive proof that cigarette smoke contains carcinogenic agents. That is what we call substances which produce cancer. Tars obtained from ordinary cigarettes, smoked in machines simulating human habits, have produced cancer when applied to the backs of mice, whereas control substances did not cause cancer.

An overwhelming proportion of people with cancer of the lung have been cigarette smokers; there is a relatively insignificant incidence of cancer of the lung in non-smokers. Cancer of the lung is increasing alarmingly each year. It seems certain that cigarette smoke is a factor here. There are enough respiratory irritants in the air without adding carcinogenic agents in the form of cigarette smoke. Lots of my doctor friends have quit cigarettes.

My impressions and conclusions are these. Nicotine is a strong poison. Almost all our drugs are poisons in large amounts, but many of them are valuable in small amounts. I have seen no evidence that nicotine in small amounts is a valuable drug. To be sure many persons feel comfortable after smoking; but opium, the barbituates, and even marijuana give pleasant feelings. It is a question of whether the bad effects do not far outweigh the good effects. This recent testimony about lung cancer is certainly weighing down the scales against cigarettes.

## *Snoring*

From the instant of our first breath the respiratory tract has been functioning steadily, except for momentary pauses. If we are in reasonably good health, this is practically effortless, when we are not driving ourselves to unusual exertions. Only

in the presence of a few diseases are we disturbed by our breathing. Nevertheless, under ideal conditions – ideal that is for the breather – this breathing has undoubtedly caused much trouble. There is one phenomenon, familiar, poorly understood and disturbing, that is directly related to breathing. This is snoring. It is ironic that our most common afflictions may be not amenable to treatment while some, rare, bizarre conditions are, at long last, being triumphantly handled. There just is not any good treatment for the common cold. On the other hand Addison's disease, which few of you have seen, but which was hopeless until recently, is now efficiently treated.

Snoring may well be classed as an affliction, despite the blooming health that characterizes most snorers. The mental picture we hold of them shows sturdy men, eating three heavy meals a day, possibly copiously indulging in evening potations, and retiring for a night of sound slumber, oblivious of all the world's troubles and particularly of the tumult which so troubles all others in their immediate vicinity. This is the common pattern, but delicate abstemious ladies, sleeping like Keat's heroine "an azure-lidded sleep," may well produce such a cacophony.

Probably any of the soft tissues at the back of the mouth and nose may interfere with breathing and thus cause snoring. It is generally believed and is probably true that lying on the back promotes snoring. The tongue and the palate drop against the posterior wall of the pharynx and the air can get down to the lungs only by roughly pushing them aside. Not all noisy breathing is snoring. It may result from obstruction in the larynx or in the windpipe or the bronchi in the lungs.

Snoring is spoken of above as an affliction. It decidedly is that, but not to the person in whom it occurs. One forced into habitual auditory association with a bad snorer through the long watches of the night may well suffer in health. The only recourse is to prod the performer into semi-consciousness and then if possible do as the remarkable Dr. Charles W. Eliot did. In his last illness he suffered much pain, but at bedtime he said that he made himself as comfortable as possible and then "hastened to go to sleep before the pain became too severe."

On one occasion when we were anchored in Tarpaulin Cove

with two snorers of distinction aboard, I took the tender, rowed to a beach shining white in the moonlight and remained there till morning. Professor Samuel Morison in his "Ballade of Jeddore" tells of another occasion when we all had to stay aboard and suffer. Our skipper had just brought the schooner through darkness and fog into a strange harbor and then, tired out –

> Everyone turns in securely
> Nought is heard but Ross' snore;
> Grunting, groaning, puffing, bubbling
> Of that sea-cook's snorty snore;
> Only that and nothing more.

## EXCRETION

Naturally as a result of the many processes continually going on in the living body, there is much waste. Wear and tear alone, of course, is a great factor. Thus, the dead skin rubs off in large amounts. Here and in the feces we have plain evidence of the disposal of solids. It is surprising to learn that most of the bulk of the feces consists, not of food remnants, but of bacteria which have taken part in the tremendous intestinal activities.

As it is said that there are about twenty five miles of sweat glands in the average human, the amount of water and impurities disposed of here is no mean factor. And the lungs do considerable giving off of water vapor, as you are well aware on frosty mornings. The chief excretory function of the lungs, however, is the removal of carbon dioxide, continually brought to them by the hemoglobin of the blood.

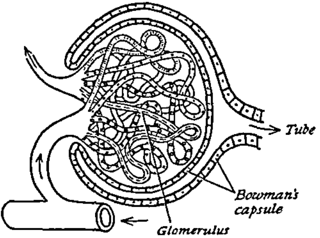
### *The admirable kidney*

This still leaves large amounts of water and waste materials to be taken away by the kidney. Probably most of you think of the kidney as the sewage disposal bed of the body. It is that, giving off impure water daily in amounts anywhere from several pints normally to many quarts in certain diseases. It is so much more, however, that an eminent scientist friend of

*mine starts his discussion of it with "a word of praise for that* admirable organ, the kidney."

It is carefully placed in a well-protected position up against the heavy muscles about the spine, overhung by the lower ribs, and with the "innards," or viscera, in front. Therefore, it is not often accidentally injured, as are the spleen, intestines, and bladder. Short of being struck by a bullet, it is rarely seriously enough injured to require removal.

This talk so far has been about "the" kidney, for although it is unusual not to have two, a description of one will fit them




The glomerulus, a unit of the kidney. (*After Vimtrup. Walter & Sayles,* Biology of the Vertebrates, 3rd Ed., *p. 434. New York: Macmillan, 1949. Reprinted by permission.)*

both. As a matter of fact, there are really about two million. Inside the tough capsule of the kidney are enormous numbers of "nephrons," which is just Greek for kidneys. Each one of these is complete in itself, doing its full share of the work.

Over a century ago, Sir William Bowman, using a microscope and a needle, dissected one of these nephrons. Each begins with a glomerulus. This is a minute coil of blood vessels, surrounded by a sack called Bowman's capsule. So Bowman's name goes ringing down the halls of fame with Alexander the Great, Napoleon, and Hitler. Unfortunately, the high pitch of men like him is rarely perceived by human ears.

At these glomeruli, fluid and waste products are filtered out from the blood, and flow from Bowman's capsule into a fine tube remarkably twisted and coiled like our intestines. Finally the contents of these millions of tubes are passed as urine.

All these tubes discharge into a sac called the pelvis of the kidney which is on the inner side towards the spine. There is no way of describing the shape of the kidney except by saying that it is kidney shaped, or like a kidney bean. Certainly there are numerous ponds here and there in the country called Kidney Ponds because of their shape. Everybody knows where the kidneys are located as shown by the "kidney blows" of pugilists and the success of patent medicine dealers in selling kidney pills to people with lame backs. Sick kidneys may cause many symptoms, but back pains are the least important of these.

Usually the kidney cannot be felt by the examiner except on the right side of a thin woman. This kidney always lies lower because of the big liver and sometimes it moves around so freely that it is called a "floating kidney." We used to stitch it up in place but I think that is rarely done now. If the patient accumulates some fat, that will usually keep it where it belongs. The blood supply of the kidney is profuse, for the blood has to be worked over thoroughly and frequently for the removal of impurities. The renal artery is a short large vessel leading from the aorta right to the kidney; therefore, there is little obstruction to the passage of the arterial blood to it and, hence, the blood pressure remains high there. About a quart of blood goes to the kidney every minute.

Practically all of the blood goes to the little glomeruli. I believe that it is generally accepted now that the glomerulus acts as a filter and extracts from the blood water and other products and does not take out the protein of the blood. There are a number of ingredients in the blood that have to be delicately adjusted, such as sodium, potassium, magnesium, calcium, phosphates, etc. All this is an intricate, important, chemical balance, which the kidneys maintain by reabsorbing through the walls of their little tubes just the right amount of these materials to serve the body's needs, and discard the rest along with the harmful waste products.

You do not need to be told that certain things increase the flow of urine — chief among these is the drinking of large quantities of water. Caffein and alcohol also are diuretics. (A diuretic is our medical term for a substance which increases the flow of urine.) It is notorious that beer drinking causes increased urination due to the intake of great bulk of water combined with the effect of alcohol.

When physicians wish to increase urination in patients with dropsy due to heart or kidney disease, they resort to the use of mercury as a diuretic. Dr. Samuel Johnson in his last illness had dropsy. Perhaps the word is not used now so much as formerly and it may be necessary to explain that it means the swelling of the body tissues with fluid. Ten months before his death, when he was evidently badly water-logged, he received "sudden and unexpected relief" by voiding twenty pints of urine in one day. Mercuric diuretics were not known at that time, but people then as now were obsessed by worry about their bowels. So Johnson, who was no exception, took "mercury," probably in the form of calomel, to stimulate these aforesaid viscera. As he had been extremely ill of asthma, he probably had been forced to complete rest. Recovery from some degree of decompensation, that is heart failure, plus the mercury, resulted in this tremendous voiding of urine.

Nervousness certainly increases the activity of the kidneys. Afternoon football practice becomes much of a routine, but the Saturday afternoon games are decidedly a different matter. For five days our rather inadequate toilet facilities in the old field house did very well. On the following afternoon with a gigantic and hostile group awaiting us outside there was always a waiting line within.

A healthy male adult usually secretes from one to two quarts of urine in twenty-four hours. Women, who as a whole seem to dislike drinking water, do not do so well as this. The amount may vary greatly; under special conditions even a good kidney may secrete anywhere from an ounce or two up to well over a quart an hour.

Other men as minutely skillful as Bowman have actually succeeded in passing microscopic pipettes into the different parts of the nephron, and have collected the fluids and analyzed

them. It is known now that within a few hours the glomeruli pass out amounts of fluid equal to all there is in the blood. But as the fluid passes down the tubes some of it may be absorbed again into the blood; or again, the blood may give up even more fluid through the tubes.

It is evident from all this that the kidneys are not merely sewers carrying off the refuse of the body, as was formerly thought, but are most efficient laboratories. They are not machines doing a routine job. The demands upon them are constantly changing.

The adult needs to take in, daily, one seventh of the amount of the body's extracellular fluid; that is, fluid in the blood vessels and between the tissue cells. The infant needs one half.

Dr. James L. Gamble, who is a pediatrician as well as an authority on body fluids, says: "The arithmetic of this is that water flows through the infant three times as fast as through the adult, which explains an unpopular item of the infant's social behavior."

It is an interesting fact that each blood vessel entering a glomerulus is larger than the vessel which leaves it. This means that the blood pressure is thereby increased locally. This presure evidently helps in passing the fluid and waste from the blood into the urinary system. Ever since the blood-pressure machine was perfected, scientists have worried as to the cause of high blood pressure, and unfortunately this worry has been shared by the general public who, of course, have had no intelligent approach to the matter. There seems to be some fairly close connection between the kidney and high blood pressure. I do not think, however, that at the present time this relationship has been fully clarified. At the time of this writing, salt is highly suspect, low salt diets are the fad, and I am told that restaurants are not cooking enough salt into their food to make it palatable. Since all the live cells of the body are bathed in a salt solution, and since there is a definite dangerous condition known as a "low salt syndrome," I think we should view this development with alarm.

The examination of the urine. A great deal of information as to the bodily health can undoubtedly be obtained by an intelligent examination of the urine. For centuries urine

examinations have been done, although there is distinct doubt as to the associated intelligence until modern times. Sir William Osler, Regius Professor of Medicine at Oxford, showed a group of us about the university in 1917, and pointed out on one of the walls a statue of a "urine caster," a bearded man holding up to the light a glass of urine. Such statues were common on buildings of medieval Europe.

For urine-casting, in those days, was considered without a rival for purposes of diagnosis. Through the centuries, differing and wondrous deductions have been made from the appearance of the urine held up to the light. From "the colours, the quantities and the qualities," the "learned and expert physician might better judge of the diseases signified," wrote Hamand in a popular work on uroscopy. "Urine running like silver, of women betokeneth she is with child, if she cast often and have no appetite. Water colour with a dark sky betokeneth death. Urine watery and thin in the aged signifies gout in the feet and joynts, proceeding from same. Greenish signifies abduction of blood, inducing yellow jaundice. Red or bloody urine may come from the liver or from a vein or the bladder, which signifies the stone." Although the physicians of medieval times made these diagnoses seriously, they were the sort that played into the hands of the quack doctors and charlatans, who by the middle of the sixteenth century traveled the country, preying on the credulity of the ignorant. So the early visual examinations were of little real value.

In modern times, the first and simplest examination is for specific gravity, or the relation of the weight of urine to that of water (which has a specific gravity of 1000). If material heavier than water is in solution, the figure is raised. Thus sea water, which has much salt in it, registers higher than fresh water. The normal figure for urine is about 1020, but this can vary greatly. For instance, a copious amount of beer taken by the patient shortly before the test will dilute the patient's urine so much that his specific gravity will be close to 1000. In diabetes, where much sugar is passed, a high reading is found.

Another test is for albumin in the urine. This is a part of the protein of which the cells of the body are largely formed.

A urine caster.

When the kidney is not doing its work perfectly, some of the albumin may show in the urine. As in all laboratory procedures, the test is of value according to the medical intelligence with which it is interpreted. This is illustrated in a story told by the late Dr. James B. Herrick of Chicago. A dignified elderly lady came to him for an examination. He found her in good shape but mentioned that she had a little albumin in her urine. In answer to her questions he tried to reassure her by saying that it was one of the changes of advanced age, just as gray hairs are. Not long after Dr. Herrick met a doctor friend who said: "I met Mrs. Blank recently. She insists that you told her that she has gray hairs in her kidneys."

Even a little more glimmering of medical knowledge than the lady possessed may lead to health worries. Many people have been disturbed by noticing in their urine a lot of cloudiness or small flakes of material floating about. This is particularly so when the urine is cold. It is caused by what we call urates, or phosphates – perfectly harmless, normal material which disappears on heating, but, of course, patients do not heat up their urine as a physician would. The medieval urine caster has developed into a highly resourceful physician using innumerable clinical and laboratory procedures.

As the urine is entirely formed in the kidneys and undergoes no change in its progress to the outside world, it seems best to discuss its characteristics at this stage. As a matter of fact modern urologists frequently pass fine tubes known as catheters right up to the kidneys and gather the urine there for examination. One great advantage of the procedure is that the urine from each kidney can be examined separately.

The *multum in parvo* apparatus usually described as two kidneys is occasionally found as one horse-shoe-shaped kidney when the upper poles have fused together. But whatever the shape presented to our rough senses of shape and touch, essentially, as stated above, there are millions of these complete apparatuses, each with the adaptability of a modern electronic device. The blood is carried to them in enormous volumes, as many a surgeon has found to his perturbation, and from it is selected, with great discrimination, water, albumin, salts, poisons, and many other substances hard to classify. All

these substances are worked over and sorted and resorted as it were.

## *The ureters and the urinary bladder*

After what is necessary has been returned to the body, the remaining urine is delivered through the multitudinous tubules and carried away by the ureters, practically always one to each kidney. A ureter is a long, narrow, muscular tube with wave-like motions traveling down it at intervals and propelling the urine which enters the bladder in spurts. The bladder is a thick-walled muscular sac and is far from being merely an

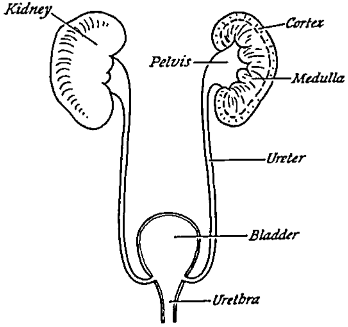



Diagram of a urinary system.

inert receptacle for fluid. The ureters enter it at an angle so that over a half inch of each is embedded in the wall. Hence, when pressure is made for voiding, the valve-like action prevents urine from being forced back into the kidneys.

With normal conditions the bladder is under the control of the will, despite any acute desire to urinate. It has the capacity to adjust itself to the volume of its contents with little change in internal pressure. Of course this varies with different persons and naturally with local disease.

We should take a most charitable view of this beneficent organ. When we find trouble here, investigation will show that it starts elsewhere and the bladder is the innocent bystander that suffers. Tuberculosis of the kidney usually causes great irritation of the bladder. Infections lower down in the lower tract react on the bladder. In severe injuries of the spinal cord the bladder sooner or later suffers. I know no bodily organ that suffers greater injustice than the urinary bladder.

### *The urethra*

The opening from the bladder is into the urethra, and is closed in both the male and female by the familiar sphincter type of muscle which acts as a puckering string, allowing no passage until it is relaxed. In the male, this first part of the urethra is entirely surrounded by the gland known as the prostate.

A goodly proportion of males would undoubtedly vote the prostate to be an unmitigated nuisance. The gland consists of several portions or lobes. For some reason which probably has to do with the endocrine system, it tends to enlarge in middle age or later. The enlargement interferes with the free passage of urine. Often the symptoms at first do not amount to much, but the time comes when the bladder is never completely empty. This situation results in frequent urination. The stagnant urine is easily infected, and the inflammation of the bladder may cause great irritation. The continued pressure may force urine back into the kidney, and particularly when inflammation is present, the kidney may be seriously damaged thereby. Men experiencing any of these symptoms or signs are wise to have an early examination, for enlargement of the prostate can usually be determined by a rectal examination. Often in the early stages, a little treatment or even the removal of a portion of the prostate through the urethra may be sufficient. In the late stages, when the kidney has been seriously injured, a great deal of preliminary treatment may be necessary *before* the patient is in condition to withstand the removal of the prostate.

In a philosophical attitude, aloof from the patient who

has experienced these tribulations, we speak of all this as *benign* hypertrophy of the prostate. Benignity is certainly a comparative term in medicine. It simply means non-cancerous. Cancer of the prostate is much more serious than the benign enlargement. Paradoxically, it is not in the prostate itself but in the sheath which surrounds it in the back that it usually begins. Besides being difficult to remove it is particularly bad because like most cancers it has a tendency to metastasize (that is, jump) to the bones of the spine or elsewhere. If taken early, it can be handled in a good proportion of the cases by an extensive, elaborate operation.

Women have no prostates, but most women have babies, and their urinary apparatus is nearly as intimately associated with their genital system as is the situation in men. The bladder is closely attached to the front of the uterus and the urethra runs in the front wall of the vagina. Hence a large proportion of women who have gone through childbirth have had injury to their urinary apparatus. Undoubtedly the worst and most common of these, which resulted from the rougher obstetrics of the old days, was a vesico-vaginal fistula. This was a persistent opening between the bladder and the vagina; most distressing and most difficult to cure. I think it is rare now.

The prostate is part of the genital system and yet, as you have just seen, it plays a large part in the urinary system. In fact the two systems are so closely related that a distinct specialty combines the surgical care of the genito-urinary system. This is particularly necessary in the male where the genital system is elaborate and the lower portion of the urinary system, the urethra, is as much a genital organ as a urinary one. Until a generation or so ago there was a goodly number of practitioners who pretty well confined their practice to diseases of the urethra. Although the late developments of disease resulted in urinary difficulties to a large extent, yet the origin was nearly always genital.

In the woman the urethra is entirely a urinary organ but it is so closely associated with the vagina, a genital organ, that here again the gynecologist takes over its care. The human body was not designed for ease in classification. Simple-indexing would be impossible.

## *Nephritis*

From the point of view of medicine the urinary system is an all or none proposition. A healthy kidney can take care of itself better than any other organ in the body in the ordinary routine of life, always excepting the heart. Bones are forever being broken, joints dislocated, muscles and tendons torn; the digestive apparatus suffers greatly from abuse; the nervous system is sadly injured by tobacco, alcohol, and popular drugs. None of these things bothers the kidney, although the drinking fraternity used to assert solemnly that "gin is good for the kidneys" while whiskey isn't. Of course swallowing a large amount of corrosive sublimate will ruin the kidneys, but that is as far removed from ordinary routine as possible.

Congenital defects of the kidney are not too uncommon. Tumors occur here at all ages. But when we speak of kidney disease, we usually mean nephritis. This was formerly more often spoken of as Bright's disease as an Englishman named Bright wrote a classical description of it over a century ago. *We do not know what causes it, and we have no cure for it,* but it is fair to say that we can care for it better now than we used to.

Nephritis may be acute or chronic. People suffering from the former type are usually very sick but still the majority of cases get well. The chronic never recover, but with careful attention often live to a ripe old age. These may well have been in Dr. Holmes' mind when he said that nothing was *more conducive to longevity than a chronic disease.* Chronic nephritis is frequently associated with heart disease — cardio-renal disease — and with hypertension, that is, high blood pressure. The kidney is a wonderful organ; especially in the way that it can survive disease.

## *Kidney or bladder stones*

The kidney shares in the troubles of the other parts of the body. Tuberculosis, which attacks any part of the body, makes no exception of the kidney. But strangest of all are

the tricks played here by some minute pieces of tissue in the neck.

The thyroid gland snugs itself about the windpipe in the front of the neck. In the tissues rather closely attached to it are usually four tiny seeds of tissue, one quarter inch in diameter and difficult to see even when they are looked for by a surgeon. These are parathyroid glands. Their big function seems to be to regulate the calcium and phosphorus in the blood. Occasionally tumors grow in these glands causing an overdose of their secretion. Then the proportion of calcium in the blood is high. The calcium is removed from the bones. One of the places where it is deposited is the urine.

Kidney or bladder stones are formed largely of calcium. Therefore when a patient is afflicted with many of these it is advisable that the doctor should suspect hyperparathyroidism; that is, increase in the activity of the parathyroids. It does not, however, necessarily follow that deposits of calcium in the body are due to this trouble. Any dead, dying, or chronically inflamed tissue may have calcium deposits. The normal kidney puts out water and solid matter which is soluble in it. If there is something abnormal interfering with the flow of urine, infection may occur here; then some of the solid matter may be precipitated, and a stone begins to form. It seems as though this might be the origin of most urinary stones.

The mere presence of a stone in the kidney may not necessarily cause symptoms. Usually these occur when the stone moves. In fact the severe symptoms most often occur when the stone gets into the ureter, the small tube leading to the bladder, and small gravel-like stones here may cause excruciating pains. Fortunately as an aid to diagnosis they are associated with blood in the urine in most cases. If the stone is on the right, the signs and symptoms may suggest acute appendicitis and produce sympathetic suffering in the breast of the surgeon who has to solve the problem.

One of the most famous historical operations before anesthesia and asepsis was "cutting for stone." Stones in the bladder were what was meant. Time was all important, as

Pieter Brueghel. Cutting for stones. A medieval

the patient was writhing in agony; and the great surgeons were sort of sleight-of-hand performers who with a few accurate slashes removed the stone in about the time it takes to tell about it. Henry Jacob Bigelow, of Boston, made a great advance from this custom in the latter part of the nineteenth century when he invented his "lithotrite." This instrument was introduced into the bladder, the stone was found by feeling, crushed, the small pieces washed out, and the procedure repeated until all the stone was gone. Dr. Bigelow was justly proud of his apparatus, which he handled with great skill, but it appears as cumbersome to us now as an old-fashioned spinning wheel.

Despite Dr. Bigelow's parental pride, it is safe to say that his admiration would be unbounded could he see a modern urologist locate the stone by X-ray, deftly bring it down by a cystoscope, or do a neat careful operation, able to see just what he is doing and to have his patient healed and well in a few weeks.

## *Tools of the genito-urinary specialist*

We doctors are frequently reminded that the patient's primary interest is to get a treatment to make him well. We feel that it is not necessary, as formerly it was thought to be, to stress the point that the prospect of such a happy result is increased if our treatment can be intelligently and accurately applied. Hence diagnosis is of primary importance. Right now would seem to be an opportune moment to speak of this, for possibly no branch of medicine has advanced more in diagnostic skill than the genito-urinary specialty. Before the present century our procedures were largely empirical. This is a striking example of a good word gone wrong. It means founded on experience. The trouble was that experience was largely similar to that of the elderly matron who felt competent to advise a young mother because she had had a dozen children of her own — ten of whom had died young.

Now blood examinations may show whether poisonous substances are accumulating in the blood when they should have been removed by the kidneys. A dye can be injected

into the blood, and the amount found in the urine can be measured to test the function of the kidneys. The urologist passes an instrument into the bladder and from this threads catheters, that is, flexible tubes, into the ureters. Thus he tries out each kidney separately. Then he injects into these catheters a fluid which will show by X-ray. In this way he outlines the hollow portions of the kidneys and the ureters running down from them.

But all this use of instruments may have too many disadvantages for a sick patient. In this case a fluid may be injected into the blood and X-rays will then determine if the kidneys are excreting it. This method again tells of the function of each kidney and the presence of abnormalities. And X-rays may also tell of the presence of stones. These are a few hints of the accuracy with which the excretory system may now be studied.

## *Water is good for the kidneys*

Water is good medicine internally or externally, and nowhere more so than in the kidney. Lawrence J. Henderson, the great physiological chemist, said that it is "the most familiar and the most important of all things." It performs its important duties because it is a remarkable solvent. No other substance can compare with it for this. It is only by regulating the strength of watery solutions that life's processes can go on. Of course you realize that the elimination of waste products which must continually go on requires water in large amounts. Even the patients with heart and kidney troubles, who are water-logged, become so, not because they have overindulged their thirst but merely because disease has interfered with the elimination of the substances which demand water in which they must be dissolved. Hence water is on the whole the best diuretic.

Clear spring water which is good to drink, without any claim to medicinal values, was presumably much more used in the old days. The habit is a good one and it can be acquired. In the old days there was a spring water sold in the city in which I dwelt; it was as crystal clear and pure as

anyone could ask for. Nevertheless, its sales would have been small had the public realized that the water so bottled had come from the city sewerage system but had been purified by seeping through a sand hill.

For centuries health resorts have been built about springs and have been known as "cures." Magnificent buildings and hotels were connected with them and they had a number of expensive medical men who conducted the "cures." The fat old dowagers and plethoric sporting men were made to diet and were depleted by the drinking of the waters. But as a leading London physician once said: "If I were to tell my patients to rise early, to frolic about Trafalgar Square, and now and then to drink half a tumbler of water from the fountain, I am sure I would get the same results."

## *Salt and salt-free diets*

If it were possible to list the more important ingredients in the body, certainly water would come first and probably salt second. Salt is so easy for us to get in this part of the world that we ignore it, but that is not so everywhere. I heard a young man tell of his experiences as an airplane observer in India, near the Himalayas. The local chieftain had no use for money, but the United States Air Force paid rent to him in salt. Some of the Roman legions took part of their pay in salt (*sal*, Latin for salt), that is why the white-collar worker is said to receive a salary.

The amount of salt that a normal healthy individual eats varies with his taste, and it seems perfectly safe to regulate it in this way when things are going along well. Dr. Oliver Wendell Holmes has been quoted, possibly apocryphally, as wanting enough food on his salt to give it a flavor. In extremely hot weather or in places such as foundries it is advisable to take large amounts of salt to compensate for that lost in sweat. All the bodily excretions have much salt.

It has long been known that persons with dropsy, that is, swelling of the body with fluid, resulting from certain diseases of the kidneys or heart, cannot excrete enough sodium chloride. Therefore, salt-free diets have been used. One of the

best known has been the rice diet. As this consists practically of rice, fruit, and sugar, it soon becomes monotonous to the point of disgust.

A friend told a story illustrating the difficulty of keeping a patient on a salt-free diet. At his place on Charlestown Pond he was visited one day by an elderly friend, accompanied by a trained nurse. After a bit the visitor prevailed on the nurse to let him gently paddle a skiff about in the shallow water. Soon the host noticed that the boat had drifted over to some rocks where the occupant seemed to find much of interest. There were oysters clinging here and there, and under the eyes of the unsuspecting nurse he was enjoying the most delicious salty snack that he had had in months.

In dropsy it is the sodium that is preventing the excretion of fluid. Of course the largest amount of sodium is in salt but many foods have some and other interesting parts of the ordinary diet are free of it. It also should be noted that potassium seems to favor the excretion of fluid as sodium inhibits it. Incidentally this is the first suggestion of an argument I have ever heard for the hard red corned beef prepared with saltpeter, that is potassium nitrate, which has replaced the lovely brown succulent beef treated with common salt in better days.

The taking of a sodium-free diet is not simple, and not everybody with kidney or heart disease or high blood pressure is necessarily a candidate for this treatment. Nor is it a panacea; digitalis or drugs to promote the flow of urine are still valuable. In the last century and occasionally in this, patients with great accumulations of fluid in the tissues have been treated with Southey's tubes. These are lovely little silver pipes stuck through the skin into the water-logged tissues. Perhaps Dr. Southey drove through the mountains in the days of horse and carriage when leisurely progress allowed an opportunity to observe the sides of the road. One might see a pipe stuck into the hillside and a steady stream of water flowing from it. In the same way actually gallons of fluid might pour from Southey's tubes, relieving the kidneys of this work and certainly giving the patient great relief—temporarily at least.

## *Kolff's artificial kidney*

In recent years a much more elaborate method has been developed to remove impurities from the blood when the kidneys are unable to do it. A Dutchman named Kolff has built a workable artificial kidney. A tube is placed in an artery of the patient. The blood flows from this through the artificial kidney and back to the patient's vein. He is given a dose of heparin, a modern drug which helps prevent clotting. A big cylinder, carrying the cellophane tube which contains the blood, rotates in a bath of water, salt, potassium chloride, bicarbonate of soda, and glucose. This solution absorbs the poisonous substances from the blood.

It is evident that if the kidney is permanently damaged, this machine is useless. In from five to fourteen hours it may clear the blood of a severely sick patient but often more of the bad substances will form later and this procedure cannot be repeated many times. Certain poisons which do not combine too firmly with the blood — barbiturates, for instance — may be quickly washed out in this way. If you have a pain in your back which "kidney pills," don't cure, it will not be worth your while to negotiate for the use of this machine. It requires great judgment as to when it will be efficient and at present the number of these cases is few.

## *Bowel movements*

I am certain that you expect me, when talking of excretion, to say a good deal about bowel movements. As a matter of fact, these movements are for the purpose of getting rid of the waste products in food and of the bacteria which, having done their work in aiding digestion, actually make the major portion of the bulk of the feces. These play a very minor part in handling the poisons which are taken care of by the kidneys, lungs, and skin. Hence the universal interest in the number and physical appearances of the feces is not justified. I do not mean, however, that the skilled physician may not learn much from them. The presence of blood or parasites, or the absence of bile, may be of great importance to him;

but these, I am sure, he would not consider under the heading, excretion.

Forty years ago a chief duty of a physician for children was to scan the stools left in the diapers. This examination for physical characteristics (color, consistency) is of comparatively minor value; and today diapers are usually sent pretty promptly to the diaper service, or the paper ones are thrown away.

The old-fashioned idea of "auto-intoxication" is no longer held by the medical profession. All the useless substances which make up the bowel movements, along with considerable water, have been dumped from the small into the large intestine. In its upper part, water is absorbed through its walls. The lower part is not for absorption; it is designed to act as a cesspool and storage space for the feces. Presumably the bowel material is poisonous, but it is safely placed in the proper receptacle, and it descends into the rectum where it lies inert, awaiting disposal.

## *The multiple functions of the organs*

The digestive, the respiratory, and the urinary or excretory systems have of necessity been taken up separately under the general heading of intake and outgo. You just cannot take any one organ or system, classify it under its chief function, and file away the data without cross-references. The man on the street will tell you that the purpose of the digestive system is to take in our nourishment and handle it. But one of the main concerns of the average man is with the outgo from this same system and he spends large sums of money to "regulate his bowels." He seems to feel that bowel evacuation is as urgently important as urinary secretion, which is not so.

In considering excretion, we cannot complacently ignore the skin. In our youth we were told a sorrowful tale of a medieval play in which golden angels were to appear. So the producers gilded over the skin of some children and caused their deaths. This experiment has probably not been tried since, but it emphasized that the skin is also important

for intake and outgo, collecting Vitamin D from the sunshine and clearing away much waste material in the sweat.

Almost anyone will concede that the kidney is an excretory organ. Yet it does not just dispose of waste and poisonous materials; it works over the plasma of the blood, selects carefully and returns to the body materials as the body needs them.

And again we must list the lungs. I doubt that anybody will be dogmatic as to whether these are more important for intake or outgo. Certainly we will die in a few minutes if the lungs do not deliver oxygen to us. But we will die almost as quickly if they do not take away carbon dioxide, a poison which we have to have to regulate breathing. It's all curiouser and curiouser, as Alice said when she visited Wonderland.

# 5. Communications and Controls

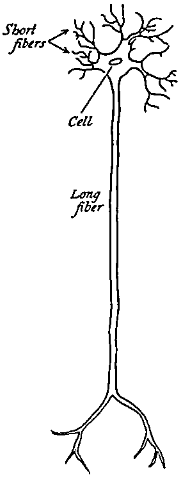
## NERVOUS SYSTEM

EVEN AN ANIMAL CONSISTING OF JUST ONE CELL HAS IRRITA-bility and contractility. These terms mean that it can receive sensations and move in response to them. As the human body develops, the different parts, as you know, take on special functions. Therefore, some of the cells of the outer layer, instead of remaining to form skin, change and become the nervous system. This receives the sensations and governs the actions of the rest of the tissues of the body. It begins to work early in life for, as is shown in Chapter I, the embryo at eight weeks of age has a large head and in it is considerable brain.

There is no doubt in the minds of us Lords of Creation that this elaborate specialized system has given us the jump on the so-called lower animals. We have intelligence, memory, affection, will power, developed in many of us to a point

never reached by animals and allowing us to triumph over them despite their strength, speed, and some highly developed senses. They far exceed us in these latter attributes, but all in vain when we really decide to overcome them.

The nerve cells bear no resemblance to any other cells making up the skin. Each consists of a body, and root-like threads coming off from the side, called "nerve fibers." These fibers may grow to enormous lengths. The cells hitch up tandem fashion, or to vary the metaphor, by holding hands when one of their fibers meets up with another fiber. Nerve impulses travel along them as electricity travels along telegraph wires. Thus they carry messages from the brain to the farthest parts of the body, or bring impulses back in the opposite direction. But the traffic is always one way; out by one chain of fibers and back by another.



Nerve cell and nerve fiber. (*After Walter & Sayles,* Biology of the Vertebrates, *p. 666. W. B. Saunders Co., 1949.*)

The place where two fibers meet is called a synapse, which is Greek for clasping, and the transfer of impulses here is a chemical reaction with a substance called acetylcholine.

Each nerve fiber is insulated by material named the sheath of Schwann, an alliterative aid to medical students. As the fibers traverse the body, they are gathered in bundles with strong connective tissue and blood vessels. Now we have something like a telegraph cable. That is what we call a nerve. The biggest one of the body, the sciatic, may be half an inch across. Nerves are exceedingly firm and tough, a great help to the surgeon as those of any fair size may be seen, felt, and handled easily.

Yet despite this solidity, and the miles of nerves which the body presumably contains, I suspect that most of you have never seen or felt one of these tough cords. The nervous system is the dominating factor in our bodies, and being so important it is not exposed to the vulgar gaze or even placed where it can be handled. On the inside of your elbow there is a groove between two bones. This spot is popularly called the funny bone and many of you have hit it just right and experienced an intensely unpleasant sensation. You have come in contact with the only good-sized nerve I can think of which is close to the surface of the body. This is the ulnar. If you hit it again and can maintain your equanimity, notice how you feel the tingle in your little and ring fingers.

The infinitesimally fine nerve filaments penetrate to the minutest parts of the body. When the blood system is described, it is likened to a tree with its big trunk, large branches, and ever smaller branching twigs, reaching to our remotest parts. To one with blurred vision the nervous system would appear much like this. The simile which I like best, however, is that of a gauzy fabric, for everywhere there are spidery cells with wavy tendrils or the finest spun threads. Everywhere — brain, cord, or nerves — there is nothing solid but the supporting tissues. Remove these latter and though the outlines of the body would remain, they would be ghost-like, ethereal to our crude eyes.

When the nervous system is entirely formed, as we find it in the body after birth, it consists of:

1. Central nervous system
   a. Brain
   b. Spinal cord
2. Peripheral nervous system
   (Peripheral means towards the further or outer surface: hence away from the brain)
   a. Spinal nerves
   b. Cranial nerves
3. Involuntary nervous system
   (These nerves are often spoken of as sympathetic and parasympathetic nerves. Many of you know

of cases where some of these nerves were removed for such conditions as high blood pressure. This was referred to as a sympathectomy.)

4. Sense organs

## *The central nervous system*

**The brain.** It would be ridiculous to attempt to describe the brain in a book like this; in fact, many large volumes could not complete the complicated task. In most animals the larger part of the brain is devoted to handling the physical functions of the body. In man the bulk of it is for the associations which give us memory and imagination and the ability to think, however poorly many of us seem to do it. I do not see how I can do better than compare it with a telephone exchange, which instead of having thousands of subscribers, has possibly millions of wires and switches, making communications practically infinite in number. The front part of our brain, called the cerebrum, is the site for these latter activities. Hence the higher foreheads of men.

The brain is a good deal of a luxury, the spinal cord taking care of most of the functions necessary for life. But after one has had luxuries long enough, they may develop into necessities; witness the automobile. A frog which has had its brain removed may live in almost a normal manner. Old-fashioned boys on a farm knew that a hen with its head cut off would scurry about for some time. But the unfortunate French aristocrats in the Reign of Terror never moved after the knife of the guillotine had fallen.

Man has an enormous brain. We are told that elephants and whales are the only animals which possess larger ones; and are not those brains minute compared to their owners' size? But size alone does not distinguish man's brain. He has many more convolutions, or folds, of the surface of the brain. This, you can see, increases the area of the surface, and it is this surface or cortex which is supposed to be the most highly developed part. The fissures between these folds have been studied, charted, and named. The biggest and best known is the fissure of Rolando. Along this, one on each side of the

brain, are the parts which control the muscular movements of the *opposite side* of the body.

Besides these "motor areas" which control the muscular motions of definite parts of the body there are other areas for sight, smell, hearing, and sensations from the different parts of the skin. Also there are certain areas, injury to which produces aphasia, which literally means lack of speech, although there are at times other manifestations, such as agraphia, or inability to write the desired letters. Thus Dr. Samuel John-

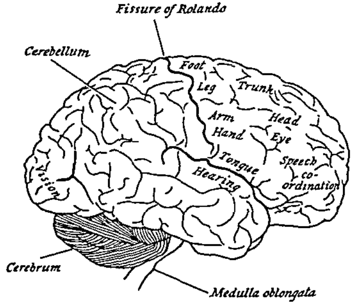



Diagram of the brain, showing localization of some of its functions.

son had a paralytic stroke which he described graphically soon after, demonstrating that his aphasia was not an impairment of the intellect. "My speech was taken from me. I made a Latin prayer in verse. The lines were not good but I knew them not to be good. In penning a note I had some difficulty; my hand, I knew not how or why, made wrong letters."

After reading this, do not be disturbed because recently when attempting to introduce your friend Jones you were unable to pronounce his name. That was due to embarrassment and nervousness, not to a lesion in any brain center.

The detailed knowledge of all these specialized areas in the cerebrum, or front part of the brain, has been accumulated over many years. In the Franco-Prussian War of 1870, surgeons, operating upon a wounded soldier, noted that when they stimulated with a weak electrical current a spot on the side of the brain, a definite localized muscular response occurred on the other side of the body. Naturally this discovery has been followed up through the years until a lot is now known. Reversing the problem, if certain muscles are paralyzed, the physician may thus get a strong hint as to what part of the brain he should investigate for trouble.

Neurologists really do know a great deal about the different areas of the brain and what goes on at these places. We call this localization and it is of great help, particularly in the surgery of the brain. But, a century or so ago, the phrenologists worked up a pseudo-science, pretending to chart many areas on the surface of the brain and analyze the traits and capacities by the "bumps" on the surface of the skull. Of course the outside surface of the skull has no real relationship to what the brain immediately beneath may be doing. A bump of "philoprogenitiveness" may have been produced by a kick from a playmate's heavy boot in childhood, which the urchin had never reported to his fond but fussy parents.

Yet with all these areas of special duties and the labyrinth of apparatus there are evidently masses of brain substance we can perfectly well get along without. I suppose that there is still on exhibition at the Warren Anatomical Museum of the Harvard Medical School the skull of a New Hampshire quarry worker and the four-foot crow bar which went in by his eye, traversed his brain, and came out through the top of his skull. Apparently the only change after this misadventure was that whereas he had previously been a quiet gentle soul, he became irritable and very profane. Neurologists and psychiatrists as well as cynics realize that people can get along without much of the cerebrum, or thinking part of the brain.

Behind this fore part of the brain, or cerebrum, is the cerebellum, just where the bulge of your skull is, above the

back of your neck. This has mostly to do with the movements of the body and is larger in many animals than in man. Then comes the medulla oblongata, which is really a big bulging at the beginning of the spinal cord. The cord emerges through a hole in the bottom of the skull, called the foramen magnum, which means the big window.

The human brain through the ages has developed into undoubtedly the most complicated apparatus in existence. It has millions of interrelationships. But it has had to sacrifice efficiency in a few things to this incredible versatility. It also emphasizes this eternal truth, that the higher up the animal, the longer is its youth.

There is an interesting and graphic illustration of the quick development of lower animals in a classic book, *The Hunting Wasps*, by J. H. Fabre. When one of these wasps is born, its parents have been dead for nearly a year. Without help it cleans itself of the remains of its cocoon, digs itself out from its cave, and starts off hunting.

There is only one kind of insect that it wants and it even insists on having a female. When it meets up with its prey, which is large and well armored, it seizes it and plunges a stinger into the one minute vulnerable place where it can reach a certain nerve ganglion. It never misses. Here it injects a drop of poison which does not kill but paralyzes. It carries the live but helpless victim to its cave and lays an egg at just the right spot on it. Having stored the larder with a number of these fresh provisions, it seals the cave, leaving the offspring to feast and rest and grow for the next ten months, when the whole procedure will be repeated by the new generation.

How different with the human child! When born it is absolutely helpless. It needs constant care and attention for years. But, if all goes well, the brain may develop to perform prodigious feats of thought. The wasp's brain never develops in the slightest after birth. On its first expedition it is as efficient as it ever will be. Fabre performed many experiments to test its power of adaptation. It had none. When presented with a difficulty that the slightest deviation from its normal procedure would overcome, the experienced wasp was as helpless as a newborn babe.

But nature is a simple-minded lady. First things are first with her. In the case of the nervous system the first things are those which keep the animal body alive and functioning. Memories, ideas, and reasoning, all those things which we take pride in calling thinking, come late. The dinosaurs, living millions or billions of years ago, evidently had nervous systems which functioned well for their everyday activities. But what we call the higher faculties developed slowly. Comparatively, in the eons of time that have elapsed since life first appeared upon the earth, these must be considered young and tender.

We are told that the inmates of insane hospitals exceed in number those in all other hospitals. The thinking part of their brain deteriorated as the more primitive parts did not. When a person is given a general anesthesia, the thinking faculties succumb first, the control of muscles much later, and the parts which have been functioning since the early days of animal life require heavy poisonous doses to stop them and completely end life.

So, what we might call this modern part of man's brain is delicate and like the complicated, finely adjusted machines which he now makes, is easily put out of order. The popular conception is that the most important part of this up-to-date brain is the "gray matter" of the surface, forming the centers spoken of above. A sharp-tongued lawyer of our town had an associate with a handsome shock of gray hair, but, in the opinion of our friend, little intelligence. The judgment passed was, "All his gray matter is on the outside of his skull." Undoubtedly these centers are necessary for intelligence, but it is the myriad of white fibers, forming an almost infinite number of intercommunications, like — to use a weak simile — the wire of a big telephone exchange, which really allow involved thinking.

All this intricate mechanism is already laid down when the poor helpless human baby is born, but it is of little avail to him until he has been trained to use it. Why a child named Charles Darwin became so adept in its use while one of the nearby farm laborers made such slight progress is an unsolved mystery. Even an examination after death would throw no light on it.

As animals become more complex and what we call higher in the animal scale, the brain becomes relatively larger and more complex. The lowest type of function we call instinct, which is inherited full formed and cannot be changed. Human babies have a few instincts, the most prominent of which is the nursing reflex. Put anything into a baby's mouth and he will start pumping in the same manner that produces milk from a breast. The comfort associated with this sucking may persist in a modified form throughout life.

Secondly, the brain acquires habits, which have to be learned at first but by repetition become automatic. In fact, the brain practically relinquishes control over these, and if it asserts itself, the result is usually bad. You run rapidly downstairs without putting your mind upon it. If you should happen to think about where you are putting your feet, you would probably have to jump the remaining stairs to save your limbs.

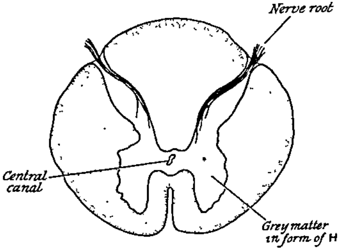
The human brain, however, can cause variable, modifiable actions which are intelligent, and powers of this kind are what put us ahead of the brutes. Actions handled in this way are not so mechanically clever as those done by habit. The late Dr. Hugh Cabot told me that the Massachusetts General Hospital once brought an efficiency expert to the operating room to see if he could not eliminate waste motions. He soon gave up in despair. It was the surgeon's intelligence which played the important part, and rarely did he feel at liberty to go blithely ahead like a sleight-of-hand man. In fact, Dr. Maurice Richardson, who was renowned for his surgical dexterity, said that almost any housewife in New England could sew more dexterously than he.

*The spinal cord.* Below the foramen magnum, in the bottom of the skull, the continuation of the central nervous system is called the spinal cord. It runs down in a bony canal inside the spinal column about as far as the small of the back. If the cord is sliced across at various levels, it will be found to vary a little in size and shape. At the neck and near the lower end it is enlarged somewhat where the nerves come off for the arms and legs. A cross-section shows a sort of H-shaped portion of gray matter inside. This consists of

cells, and it is injury to these which causes the paralysis of poliomyelitis. The rest is white nerve fibers running down the cord.

## *The peripheral nervous system*

**The spinal nerves.** As these fibers leave the cord, they form nerve roots, the motor fibers in front and the sensory ones in back. Then the roots are joined together in a series of bundles now called nerves. There is, on each side, one nerve for each vertebra. As the body is developing, it grows

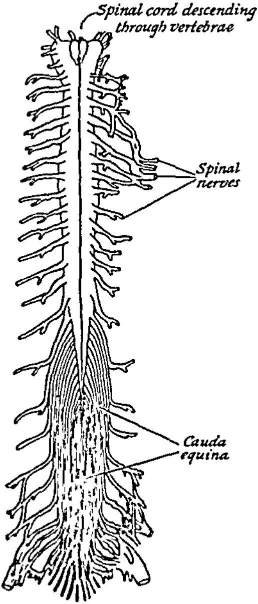



Cross-section of the spinal cord. (*After Cunningham,* Anatomy, *p. 523. W. Wood & Co., 1903.*)

faster than the cord does, so the nerves do not leave the canal immediately as they come off but run down for varying distances inside. This collection of nerves in the part of the spinal canal below the cord is called the cauda equina, or horse's tail.

Each nerve as it leaves by its own special bony pathway is a mixed motor and sensory nerve, but it does not long remain so. The motor nerve has its cells in the cord and its fibers may run from there to the remotest part of the body. From these distant places the sensory fibers come back to knots of cell bodies called ganglions. These are just out-

side the spinal column. Fibers from there form the posterior roots mentioned above and continue into the cord.




Spinal nerves, emerging from cord between vertebrae. (*After Walter & Sayles,* Biology of the Vertebrates, *p. 651. W. B. Saunders Co., 1949.*)

What has been described so far are the nerves in Section 2 of the classification above — the peripheral spinal nerves. We

have a good deal of control over these nerves, but not absolute. For instance, one could direct them to move the hand and pick up a piece of metal. But, if the metal were unexpectedly hot, it would be dropped and the hand snatched away before any thinking came into play.

**The cranial nerves.** The spinal nerves are numbered according to the vertebrae where they emerge. There are twelve pairs of nerves very similar to these which come directly off the brain, and emerge through holes in the skull, or cranium. Hence they are called cranial nerves. They are both numbered and named. Medical students are forced to memorize a most discouraging number of facts. For aid they often resort to doggerel, some of it vulgar, for vulgarity is often closely associated with the facts of life. The cranial nerves, however, are memorized by the aid of verse chaste enough to be safely quoted here. Here is the list of the *cranial nerves, their numbers, names, and duties.*

### Cranial Nerves

| | | |
|---|---|---|
| I. | Olfactory | Smell |
| II. | Optic | Seeing |
| III. | Oculo-motor | Most of motions of eyeball |
| IV. | Pathetic or trochlear | Moves eye upward. |
| V. | Trigeminal | Feeling in face. Moves chewing muscles. |
| VI. | Abducens | Moves eyeball to side. |
| VII. | Facial | Moves most of muscles above neck. Taste and saliva |
| VIII. | Acoustic | Hearing and balance |
| IX. | Glosso-pharyngeal | Muscles and sensation in mouth and throat |
| X. | Pneumogastric or vagus | Handles many things from ear to stomach. |
| XI. | Spinal accessory | Moves muscles in neck, chest, and shoulder. |
| XII. | Hypoglossal | Pulls back tongue after it has been extended. "Not so effectual in more difficult task of retracting what tongue has chanced to say." (Walter) |

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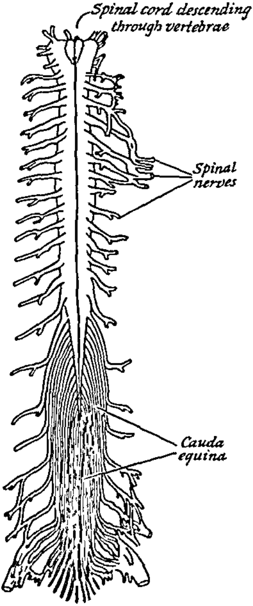


Spinal nerves, emerging from cord between vertebrae. (*After Walter & Sayles,* Biology of the Vertebrates, *p. 631. W. B. Saunders Co., 1949.*)

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Here are the twelve words which help us to memorize these nerves. You will notice that the first letter of each is the same as that of the corresponding nerve. On- Old- Olympus'- Peaked- Tops- A- Finn- And- German- Picked- Some- Hops.

Animals vary greatly in the comparative size and usefulness of these different nerves. Most wild animals find the sense of smell absolutely necessary for their existence. Without it they would have practically no defense against their enemies. A dog kept as a pet could probably get along, but he would have a very sad time.

Smell in humans is not much more than a luxury, although it does take part in taste and has considerable effect on our digestive system. It is evident that our smelling apparatus is very inefficient. It takes a strong odor, from the point of view of an animal, even to make us aware of its presence and our smelling is quickly fatigued. The delicate fragrance of flowers, for instance, soon ceases to be noticeable if we stay with it.

On the other hand, sight is highly important to us and our optic nerve is a large and efficient one. Our facial nerve is a busy one, for the muscles of our face are many and active. When someone commented on the old features of David Garrick, the actor, Samuel Johnson replied that it was natural, for Davy's features had much more wear and tear than other mens'. The sensations and motions of our mouths and throats are so many and important that the nerve supply here is great. Our acoustic or hearing nerve is undoubtedly sluggish as compared with those of most animals. The answer to all this, of course, is that for our purposes our nerves do pretty well, but we could not compete with the animals in the struggle for life if the outcome depended on what we can do with our nerves.

### *The involuntary nervous system*

Many animals can, of course, live with little or no brains. This fact is also true even of some pretty complex forms of life. The functions actually necessary for our continuous existence go on with little or no connection with the brain, particularly as far as the control by involuntary nerves is concerned.

The heart beat and movements of the digestive tract go on even when we are unconscious.

But even the motions of the muscles over which we think we have brain control are largely automatic. Who of you have not had your "knee jerks" tested? The tendon from the big muscles of the front of your thigh is struck just below the knee. The sensation produced goes up to the spinal cord, stimulates the nerve which causes the muscles to move, and you kick without your brain telling you to.

It is interesting to realize that the more skillful the actions of your muscles, the less your brain knowingly controls them. A base runner starts to steal second. The catcher whips the ball down there. Should the shortstop think his motions out as follows: "I will now catch the ball; having caught it, I will now move it over to touch the runner", it is certain that the runner would be safe. Instead, the player, having done this act a thousand times, repeats it with no help from his brain and at the same time moves his leg over to avoid the runner's spikes.

## *Cerebro-spinal fluid*

All these nerves are protected by sheaths of tougher tissue. The fibers of the central nervous system are left bare, but man's brain and spinal cord are surrounded by three layers of membrance, called meninges. They are possibly little known to you except as they become infected, thus producing meningitis. In between these membranes is the cerebro-spinal fluid, which allows of a little motion and cushions shocks to the delicate nervous tissue. The fluid not only surrounds the brain and cord but fills some spaces inside the brain. Within each side of the front part of the brain is a space lined with many fine blood vessels, and most of the fluid is formed there.

From these lateral ventricles, as they are called, the fluid passes into a central chamber called the third ventricle. From here is a little passage whose name I love—*iter a tertio ad quartum ventriculum*—the canal from the third to the fourth ventricle. Also called the aqueduct of Sylvius. I enjoy flattering myself that liking these old historical names is in the

nature of preferring a Goddard desk to a Grand Rapids table.

From this ventricle the fluid goes through a lot of little holes to the spinal cord and the outer surfaces of the brain and cord, surrounding them. Afterwards it is absorbed into some big sinuses or veins around the brain. You see that it is a sort of little circulation in itself.

The fluid is always under pressure. When physicians want information about it, they put a needle between two of the lumber vertebrae; that is, in the lower back. Sometimes for unusual conditions they make a cisterna puncture at the back of the neck just below the skull. This latter is a much more tricky procedure as it is near the medulla oblongata, the very delicate place where the brain and cord join. But sometimes a puncture here is of great value.

As the fluid runs out through the needle, its pressure can be measured. Low pressure is not particularly important but high pressure may be. Inflammation or tumors may make great pressure as may injuries with resulting bleeding within the skull. Certain drugs are said to increase pressure. Morphia is one of these, which is unfortunate as it may lead to patients' being refused morphia when they are suffering great pain.

The color of the fluid may give valuable information. Ordinarily it is clear and colorless, like water; in certain conditions, as some types of meningitis, it is turbid or cloudy. For years neurologists impressed me greatly when they spoke of the gold curve, meaningless to me, and especially with their references to xanthochromic fluid. I have always stood in awe of these learned men, but a few years ago I looked up xanthochromic and found that its full meaning is just yellow-colored, expressed in Greek. Words like this are a harmless hobby of neurologists and psychiatrists, who really know a lot of things that you could not understand in any language.

So let us hope that you never have to get concerned about your spinal fluid. If the examination proves "interesting" to the physicians concerned, that probably means trouble to you. With you, as with the little Eton boys, sporting on the banks of the Thames: "Where ignorance is bliss, 'tis folly to be wise."

Nowadays a goodly proportion of you have had your attention called to the spinal fluid by the familiar spinal anesthesia.

Once again a lumber puncture is used for that is the easiest place to introduce a needle. A few drops of fluid are first removed and the drug which produces the anesthesia is dissolved in this and introduced into the spinal canal. There are lots of little tricks to have the anesthesia begin at the desired level, to make it last longer or shorter times, etc. Both feeling and ability to use the muscles are stopped in this way.

### *The well-protected brain and spinal cord*

I should say that the chief of the original functions of the fluid is that of protection. The pressure due to any swelling in the central nervous system by means of this fluid can be distributed over the whole area rather than concentrated dangerously at any one point. Nothing in the whole body is more carefully protected than the brain and cord. The skull makes a very strong bony case and even if it is broken, that is not necessarily serious. It is what happens to the soft parts within that counts. I would say that the spinal cord is even more carefully protected. The "backbone," as we call the whole bony combination, has twenty-four vertebrae as well as the sacrum and coccyx at the botton. The resulting great number of joints allows it to give, rather than break, but each joint normally gives but a mighty small distance.

The vertebrae lock firmly together. Their powerful ligaments imbed them in great masses of gristle. The whole is reinforced by the muscles of the back, most powerful in the body. Could you have this demonstrated to you, I do not see how you could help being skeptical of the "manipulators" who find that your physical ills are due to the displacement of these vertebrae and who put them back in place. We physicians do occasionally see dislocated vertebrae, usually in the neck after severe accidents. They are pretty apt to result in paralysis if not death.

The powerful unyielding protecting walls not infrequently are a disadvantage. If a tumor or bleeding or other condition causes increase of bulk, the rigid walls allow no room for swelling and increased pressure results. The delicate nervous tissue can stand little of this and the results may be disastrous.

One distressing result of this lack of spare space has received

much publicity of late years. That is the pain and disability usually in the lower back but at times in the neck associated with a "slipped disk." Between each pair of vertebrae is a mass of spongy springy material which cushions shocks and allows guarded movements. Sometimes this ruptures and pushes into the spinal canal. But a nerve is always present on either side between the vertebrae, and space is limited. The displaced material therefore causes pressure on the nerve and resulting pain. Surgical removal of the disk is often necessary, although this is far from being always the case.

Perhaps the most striking thing about the nervous system is its lack of the power of regeneration. Destroy a nerve cell and it is gone forever and no other will take its place. However, the nerve fiber may be injured somewhere along its course. All the part thus separated from the body of the cell will waste away. But from the point of injury the wounded cell may slowly push out fresh fiber. Even this regrowth compares poorly with what we get in other tissue. Surgeons cut many tissues which in a few weeks may be as good as new. If they cut across a nerve fiber, the function of that nerve is lost for many months. Nervous tissue also is delicate and easily injured. That is why the brain and spinal cord are protected as no other parts of the body are.

This system is the great regulator of the body. Even the endocrine system, whose importance is so recognized now, is said to be dominated by the pituitary and this latter is lorded over by a part of the brain. Once it is necessary to activate the body, the nervous system is in command.

## SENSE ORGANS

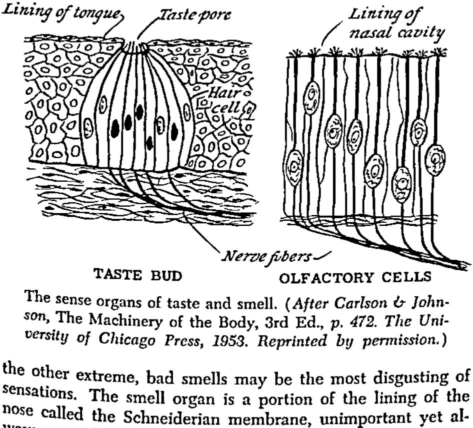
Man cannot live by himself alone, but only by contact and association with the outside world. The nervous system as described above could never give him this contact. It has to be done by the sense organs.

From the time of Aristotle it has been customary to speak of man's five senses: sight, smell, hearing, taste, and touch. The tiny sense organs in the eyes, the nose, the ears, the mouth, and the skin receive their stimulation from the outside; then the sensory nerves transmit the stimuli to the brain which is

where man becomes aware of these sensations. Perhaps Aristotle and his fellow-Greeks could live their simple lives with five kinds of sense organs. We are told that the modern man has about twenty-five.

## *The sense of smell*

In the animal kingdom as a whole probably smell is the most important sense. It would seem to be of minor importance in man, who considers it almost entirely from the aesthetic point of view. It pleases him to smell the perfume of flowers; it contributes to his taste of some of the most flavory foods. At




The sense organs of taste and smell. (*After Carlson & Johnson,* The Machinery of the Body, 3rd Ed., *p. 472. The University of Chicago Press, 1953. Reprinted by permission.*)

the other extreme, bad smells may be the most disgusting of sensations. The smell organ is a portion of the lining of the nose called the Schneiderian membrane, unimportant yet always remembered by a medical student.

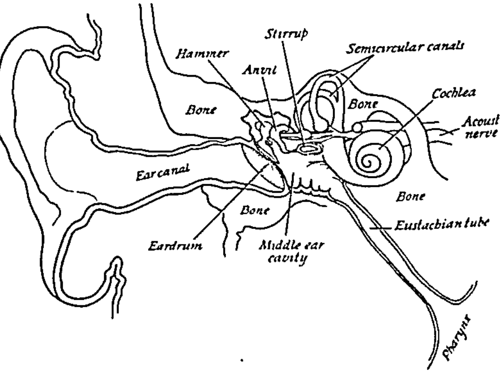
## *The sense of taste*

Most of the tasting is done by numerous little bumps on the tongue, and different parts of the tongue seem to specialize in sweet, sour, salt, etc. Some of the pleasantest tastes are due

largely to smell—for instance, wine and onions. Smell and taste are relatively unimportant in man and there is evidence that they are becoming more so.

## *The sense of hearing*

Hearing is of great importance, and man has developed an elaborate and delicate apparatus for it. The outer ear is of




The cochlea contains the organ of Corti, from which the acoustic nerve leads to the brain. (*After Max Brödel,* "Three Unpublished Drawings." *Philadelphia: W. B. Saunders Co., copyright 1946.*)

little importance in man, although animals move it about to catch the air vibrations which produce sound. These vibrations may strike the bone in which the other parts of the ear are embedded and hearing may be had by "bone conduction."

The best hearing, however, comes when the waves of air go through the ear canal and cause a membrane, the eardrum, to vibrate. On the inner side of this is a hollow space, kept filled with air through the Eustachian tube which connects with the throat just back of the nostril. As the air at sea level is said

to have a pressure of fifteen pounds to the square inch and varies at different levels, it is important to keep the pressure equal on the two sides of the eardrum. The tube ordinarily stays closed, but swallowing or other movements of the throat open it, so now you know why you should chew gum when the airplane leaves or lands on the ground.

This little chamber or space described above is the middle ear. Attached to the inner surface of the eardrum is a minute bone called the malleus, or hammer. It is one of a chain of three bones with joints between them. The middle one is the incus, or anvil; and then comes the stapes, or stirrup, which is attached to another membrane on the inner wall of the middle ear. This membrane covers a fenestra, or window, which would open into the inner ear were it not thus closed. The space for this inner ear is carved from the hardest bone in the body, the petrous portion of the temporal bone. It is filled by a sac or sacs of fluid and along the wall are a number of microscopic structures.

Certainly the best known and probably the most important of these is the sense organ of hearing, called the organ of Corti. Its complex structure is microscopic, but it is said to have as many as fifty thousand "hairs" projecting into the fluid. These hairs connect with the fibers of the eighth or acoustic nerve. Thus the brain is apprised of the physical effects which produce sound. Corti was an Italian of a rich, noble family yet he labored for years in the dissecting room and laboratory until he discovered and described one of the tiniest intricate pieces of apparatus in the body. Having done this he inherited the family fortune with the title of Marchese, dropped entirely his interest in medicine and did not even save his microscope. Perhaps he felt that anything more he did would necessarily be anticlimatic after this monumental work. Perhaps he felt that he was entitled to a broader, varied life.

Oliver Wendell Holmes writing of his ancestress, Dorothy Q, says:

> Soft is the breath of a maiden's Yes,
> Not the light gossamer stirs with less.

Yet that gentle sibilation moved air waves to her lover's ear, causing his tympanic membrane, a very firm structure, to

vibrate. Then the three bones of the middle ear relayed the motions accurately, even though one of them was held steady by a muscle, the tensor tympani. The last of the series of bones then had to move another membrane, and this movement set up currents in the fluid of the inner ear causing fifty thousand hairs to wave to and fro. These motions affected the acoustic nerve, and the brain finally received and evidently rapturously responded to this wonderful phenomenon. An elaborate method of transmitting these faint vibrations but it works.

The ear and the sense of balance. It is difficult to understand some of nature's associations. Although hearing and balance would seem to be unrelated, the sense of hearing and a major part of the sense of balance are both achieved through the ear. The acoustic nerve, the nerve of hearing, also sends fibers to the part of the inner ear concerned with balance. You must understand that the cavity in the bone which houses the inner ear is not a simple chamber but a complicated system of tubes called the labyrinth. Three little curved parts are called the semicircular canals. Two of them stand upright at right angles and the third is on its side. Whenever the body changes its position, the fluid in these canals moves, as you can see it do in a carpenter's or mason's spirit level. This change of position and pressure is felt by the nerve endings and carried to the brain. With most of us, too frequent and sudden motions of the fluid make us dizzy and finally sick. You are not abnormal if the continuous motion of a ship makes you seasick.

I think that we may agree that the ear is the most remarkable mechanical system in the body. I have not begun to recite the workings of all the gadgets it possesses. I did mention the tensor tympani, a minute muscle which puts a tension on one of the tiny bones that moves with sound waves. It has another use. Sound is carried through the bone which encloses the ear. Hence it would not be remarkable if our voices, our chewing, swallowing, and pulsation of the blood vessels sounded to us like a modern orchestra. It is believed now that the tensor tympani may counteract these noises by compensatory pressures on the fluid of the inner ear. Many people are much disturbed by ringing in the ears and other noises. The best preliminary to successful treatment is a knowledge of the under-

lying cause. So if the tensor tympani may be the guilty party, perhaps we have made a start towards controlling this nuisance.

**Infections of the ear.** In the past, infections of the ear have been a common and serious problem, especially in children. Most "acute ears" were treated by a little incision through the eardrum which let out the infected material. If this was not done soon enough, the infection would travel through the air spaces in the mastoid bone just back of the ear. Then an elaborate operation was done to remove the infected bone. Now the use of antibiotics has almost abolished the surgical treatment. The secretary of a very busy pediatrician just told me that she has been in the office for twelve years and she knows of only one ear which was opened during her time.

**Lempert's operation for the relief of deafness.** It is hard to keep the surgeons down, however. Surgery for infection has gone, but Dr. Julius Lempert, of New York, has developed an operation for the relief of deafness. It has a most delightfully musical title: the fenestration operation for otosclerosis. Translated into the less accurate and more long-winded Anglo-Saxon, this means cutting a window into the ear because of hardening of the flesh. The surgeon cuts through the tissues and bone until he makes an opening into the middle ear. Then the air waves travel through this opening and strike directly on the apparatus which sends sound to the brain. The great trick is to make this opening so that it will not heal again and leave the patient in the original condition. Nature has a tremendous urge to repair any injury done to the body. Ambroise Paré, the great French surgeon of four hundred years ago said: "I dress the wound, God heals it." Surgeons of those days poured boiling oil over battle wounds. Paré found that wounds which escaped this horrible procedure did much better. Dr. Lempert had to treat gently the wounds going into the inner ear and they had a tendency to heal over completely. However, he now feels that he can do the operation so that the wound will heal and still leave a channel open for the air.

**Hearing aids.** As people are living to an older age now, more of them are realizing that with the advancing years all their tissues have a tendency to lose elasticity and pliability. This situation in the ear does result in the hearing being less

acute. Fortunately hearing aids are being improved, and, what is also important, they are getting to be as good form as eye glasses. There is an occasional person whose deafness is due to degeneration of the acoustic nerve. So check with a good ear surgeon before you buy your hearing aid.

It may be that within a few years hearing aids will be as popular as eye glasses. An article in the *British Medical Journal* said that a recent visitor to New York was impressed by the number of people in the street wearing hearing aids, and the same might be said of London now.

There is no doubt that they are a great help to many people. Children at schools for the deaf, if they have a small remnant of hearing, now use them. I am told by a physician, deaf himself, that it is very important to recognize deafness in young children. Not only are deaf children thought to be stupid, unjustly, but it is important that they receive training in hearing. He also says that the parents are the ones to determine this, not the otologist, that is, the ear doctor. He suggests that they stand where the child cannot see them and say softly, "Want some ice cream?" Any American child who does not respond to this is definitely abnormal.

Training in the use of hearing aids is important for older people as well as for children. Probably many get too much noise and this is confusing. There is an organization to help the hard of hearing get the best — for each one — type of aid.

I suggested to my deaf friend that there might be some unnecessary wearing of hearing aids as there is of eye glasses. In my youth my family sent me to a man who measured my eyesight, found that it was not perfect, and prescribed glasses. I wore them all through college. At medical school I got my first medical graft by going to a Boston oculist, a teacher in the school, who showed *esprit de corps* by charging me nothing. He said that I undoubtedly had a slight error of refraction, but that if they were his eyes he would do without glasses. I took his advice and went twenty years or so without any. My deaf friend says that this does not work with ears. He is in a position to know. I guess, though, that hearing aids are a greater nuisance than glasses, even bifocals. They are very expensive, the battery upkeep is to be considered, various parts

of the apparatus may break, and they are considerable to carry around. People used to be ashamed of hearing aids, although why more so than of glasses it is hard for me to see. Probably soon they will be as much the mode as dark glasses are now.

## *The sense of sight*

Although, without hearing, man is sadly cut off from natural communication with his fellows, there is pretty general agreement that sight is the most important sense which he possesses. The others are local, and even hearing is rarely of use except for sounds fairly close by. Sight allows us to appreciate things as far distant as the stars. It is with the greatest difficulty that we compensate for the loss of sight even with nearby familiar things.

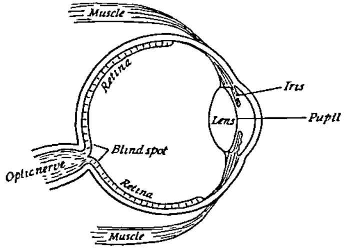
Our sight is well guarded. The eyeball lies within the strong bony cavity or orbit and the nerve of sight is back of this, embedded in a soft mass of protective fat. The reaction of our eyelids is extraordinarily quick. Anything approaching the eyes causes them to close instantly, often even without our knowledge.

The delicate outer surface of the eyeball is kept continuously moist by a steady flow of salty tears from glands just above the eye. This washes away all fine dust that has not been caught by the eyelashes. Other glands in the upper eyelids secrete a fatty material that keeps the lids from sticking together and also keeps the flow of tears from running over. Most of this liquid evaporates but some runs through a small canal from the inner corner of the eye into the nose. Hence the blowing of the nose so common at plays, weddings, etc., when people do not want to admit their sentimental weeping.

This weeping is a peculiar phenomenon, peculiar to the human race. It is evidently a recent acquirement of human beings, biologically speaking. Babies do not weep until they are about two months old, and no other animal weeps, despite the references several centuries old to crocodile tears. It is an emotional affair – people weeping for joy as well as for pain and sorrow. It often gives physical relief from mental tension. And it is sometimes embarrassing.

The eyeball is a globe with an exceedingly tough wall and a front surface that must be the most delicate in the whole body. You may be barely able to see a speck after it is removed, although while under the eyelid it caused you anguish. The steady flow of tears saves you from many such unpleasant episodes.

As a piece of apparatus for receiving, transmitting, and recording light waves, the eye is much like a camera except in its shape. This globe shape allows the six muscles attached to its outer surface to move it like a ball and socket joint. They are fastened far enough forward so that they do not pull against




Structure of the eyeball.

the point of attachment but curve over the surface as a baseball pitcher's fingers curve over the ball, giving a firm hold. Ordinarily the two eyes move together, thus keeping both focused on the object. Unfortunately some children have muscle trouble, resulting in a squint, and they cannot do this double focusing. Such children should be seen promptly by competent oculists, for many of them need the shortening or lengthening of one of these muscles.

Helmholtz, the great German scientist, said that he could design an apparatus for seeing which would be more efficient than the eye. Perhaps he could have made one for temporary use. But would it have worked well in bright sunlight, fairly well at night, also under water; would it have been kept in good

order by home repair while still in use; would it have been fairly efficient after nearly a century of use and capable of developing pictures far more quickly than a modern polaroid camera? Also could it have taken colored pictures under poor lighting conditions, carried an unlimited supply of films, and been capable of instant focusing for near or far distances?

Even with the eyelids closed there is enough transparency to allow us to distinguish between darkness and light, but the light rays which we really use for sight must come through the pupil. The size of the pupil is automatically regulated by the surrounding iris which consists of two muscles, one to open and the other to shut. These muscles act more quickly than any other involuntary muscles. The pupil enlarges when we look at distant objects, contracts for near ones. There is much more variation, however, produced by varying amounts of light. Bright lights cause small pupils. In the darkness of night the pupils become very large.

In certain conditions, such as syphilis of the nervous system, there is a phenomenon known as Argyll-Robertson pupil: the pupil will contract as an object approaches it, but will not do so when a bright light shines upon it. A generation or so ago these actions of the iris made the front pages of newspapers. Harry Thaw, a rich playboy, was being tried for murder. The defense was insanity, which not infrequently in those days was caused by syphilis. District Attorney Jerome, of the family from which Winston Churchill, through his American mother, got a goodly part of his ability, sought to discredit the defense psychiatrist, who was, in the language of the present day, a four-flusher. He asked him if Argyll-Robertson was one man or two. The answer was really of little importance, but the witness, instead of admitting that he did not know, foolishly guessed two. This mistake of the psychiatrist served to raise the name of a Scotch physician from comparative obscurity to considerable fame, as well as to show how, in the anfractuosities of the law, a reaction of the eye may become important, legally.

In both a camera and an eye the entering rays of light pass through a lens which focuses them on the back wall. The lens of the eye is enclosed in an elastic capsule. As this is tightened or loosened by muscles, the shape of the lens changes accord-

ing to the distance from the object looked at. This adjustment is known as accommodation and in the normal eye it allows one to see clearly either near or far. Unfortunately many eyes are not normal. The most common difficulty is that the front to back dimension of the eyeball is either too short or too long, so the light rays cannot be focused accurately on the back wall. Then the direction of the light rays has to be changed before they enter the eye. This is done by spectacles.

So far, so good; but elderly people do not need to be reminded that the spectacles which did a perfect job for them at twenty-one are not at all what they need at sixty-one. There are two principal reasons: change in the shape of the eyeball, due mostly to the pull of the muscles attached to it, and also changes in the shape of the lens. At any rate, persons who have been very nearsighted in early life may find that they may dispense with their glasses in later years, while we who started clear sightedly forth in our youth find ourselves baffled by the obscurities of the telephone book.

A good lens is crystal clear, but unfortunately opacities sometimes occur, forming the well-known cataracts. My medical dictionary has eleven inches of fine print listing the different varieties. The least displeasing to me is the "incipient cataract . . . sometimes remaining unchanged for years."

The picturesque name, cataract, developed because a film seemed to "drop" down over the sight, obscuring vision. Occasionally cataracts appear in the newborn infant; sometimes they follow as the result of disease or injury of the eye. By far the most common is the senile cataract, developing usually after middle age and seemingly a part of the aging process. Fortunately a great many such cataracts develop slowly and in one eye more than the other. The duty of the ophthalmologist is to judge whether the patient is getting along well with the better eye and when the cataract is "ripened," that is, in the best condition for removing. When the proper time has arrived and the operation has been well done, then powerful glasses may give good vision.

So far the apparatus for handling the organ of sight has been described. The real sense organ is the retina, covering about two-thirds of the inner wall of the eyeball. The other sense

organs of the body are formed at the ends of nerves. The sensory part of the retina and the optic nerve itself are really an outpushing of the brain. It is decidedly different from anything else in the body. There are said to be seven million cones in the retina and one hundred million rods. Cones register the different colors, while the rods give us colorless vision even with poor light.

Strangely enough, sight is a chemical process. There is formed in the retina a substance called visual purple. In recent years it has been found that the visual purple cannot be produced in the absence of Vitamin A. Hence night blindness is a striking symptom of this avitaminosis. A knowledge of this phemonon has contributed to the art of the X-ray specialist. These physicians do some of their most important work in the dark room, studying faint shadows on the fluoroscopic screen. Light uses up the visual purple quickly. With plenty of daylight we see well enough, but we seem almost blind when we first enter a dimly lighted movie house. Some of this is due, of course, to the contraction of our pupils. So after lunch my friend Dr. B., the roentgenologist, puts on dark red glasses. These allow the visual purple to accumulate and the pupils to open wide. If he has plenty of time he spends a few minutes in the absolute darkness of the examining room before he begins, with the eyes of an owl, to look at the screen.

There is another way in which sight fatigue may be demonstrated. After you have looked for a while at a brilliantly colored landscape, turn your back on it, stoop over, and survey it between your legs. The increased brightness of the colors will reward you for the undignified attitude that you have assumed. You are using another part of your retina where the visual purple has not been so much used up.

Helmholtz, who thought that he could design a better eye than the one we use, was really one of the greatest of scientists. Among his many achievements was the invention of the ophthalmoscope. This device consists of a circular mirror with an electric light bulb placed at its center so that the light is reflected into the interior of the patient's eye through the pupil. At the upper edge of the mirror is an opening through which the posterior, internal surface of the eyeball can be viewed.

Attached to the machine is a disk which allows any one of a series of lenses to be placed over the opening, thus bringing the retina into exact focus. To the modern physician the ophthalmoscope may be as valuable as the stethoscope. Many abnormal conditions in the body — diabetes, kidney disease, high blood pressure, and brain tumors, for example — cause changes in the eye, chiefly in the blood vessels. This gives valuable clues in diagnosis.

**Dr. Samuel Gridley Howe, helper of the blind.** Many great minds have studied optics, the science of light; and led by Helmholtz, they have applied these studies to help human sight. All in vain, of course, is this work to those who have lost their sight. One man, certainly not a great scientist, is outstanding as a helper of the unfortunate blind. Yet, though he was one of the most colorful and forceful men we have ever had, when his daughter died a few years ago, our leading news magazine referred to her as the daughter of Julia Ward Howe, author of "The Battle Hymn of the Republic." Comparatively few would have been enlightened had they been told that her father was Dr. Samuel Gridley Howe.

His portrait, painted in oil, hangs in the John Hay Library at Brown University. It shows a handsome, slender, black-haired young man with a long old-fashioned rifle on his knees. He is attired in an elaborate Greek costume; all this in keeping with his romantic, chivalrous youth.

Born in Boston, he came to Brown because he was the best reader in a family which could afford only one boy in college and which was opposed to Harvard politics. Nevertheless he took his M.D. at Harvard. There were not any internships in those days; but Byron had written of the isles of Greece, "where burning Sappho loved and sung"; and he had joined the Greeks in their war against the Turks. So Howe offered his sword and surgical services to the Greeks. Nowadays a doctor is a noncombatant; he "only became a surgeon when the fighting was over." After three years of guerilla warfare and several years of distributing American help in Greece he went to Paris and wished to get into the 1830 Revolution, known as the Three Days, which put Louis Philippe on the throne; but Lafayette told him, "this is our battle."

Returning to Boston just as the Asylum for the Blind was

established, Howe was chosen to run it. He went to Europe to study schools for the blind, got mixed up with Polish relief, was thrown in prison in Berlin, from which the American government managed to rescue him, but never again could he go to Berlin. So far he certainly had not been much of a doctor. A great Boston merchant with the magnificent name of Colonel Thomas Handasyde Perkins gave his house and grounds for what has since been the Perkins Institute. Dr. Howe improved the methods of teaching the blind and developed printing with raised characters which could be felt. Soon he heard of a seven-year-old girl at Hanover, New Hampshire, who had had scarlet fever at two years of age, leaving her blind, deaf, and with taste and smell blunted. This was Laura Bridgman. He brought her to Boston and with unending patience and ingenuity educated her so that she became a capable woman. Since his day blindness has not been the handicap it formerly was.

Our hearing and our sight are what really make us part of the world around us. The lengthening of man's days and the coincident development of aids to vision and hearing are, however, making us more tolerant of imperfections in these senses. We no longer expect to be treated as was the hero of Mrs. Thrale's "Three Warnings." This lady may be remembered by you as the friend of Dr. Samuel Johnson. She wrote a poem with the above title which got into many of the school anthologies of the last century.

Farmer Dobson had been promised in his youth, by Death, that he would be given three warnings before being taken away. When Death finally came, he told his victim that he should be satisfied with his long healthy life, but Farmer Dobson insisted that he had many infirmities. Then Death replied:

> "If you are lame and deaf and blind,
> You've had your three sufficient warnings;
> So come along, no more we'll part,"
> He said, and touched him with his dart.

## *The sense of touch*

We would not know much of the rest of the world if we could not see or hear. Portions of both the eye and the ear are formed

from the skin; and Laura Bridgman and Helen Keller, reverting to more primitive conditions, overcame blindness and deafness by the sense of touch in the skin. Of course they combined this with more intelligence than did John G. Saxe's sextet:

> There were six men of Hindustan
> To learning much inclined,
> Who went to see the elephant,
> Tho all of them were blind,
> That each by observation
> Might satisfy his mind.

As they severally felt the side, leg, ear, tail, trunk, or tusk they respectively decided that the elephant was very like a wall, tree, fan, rope, snake, or spear. The "educated finger" of the surgeon is developed throughout his practice to obtain delicate feeling and is a great aid to him. To intensify this training many surgeons use only one hand for this purpose, handling instruments with the other when it is necessary to work by feel. Almost never do I feel a pulse with my right hand.

Different parts of the body vary greatly as to the amount of touch sensation that they have. The skin of the finger tips is, as you know, very delicate in its feeling. You could not begin to feel a touch in the small of your back as you would on the finger. There is another interesting element about the sense of touch which physiologists call "tactile discrimination." The other evening I placed two pencils side by side so that there was possibly a quarter of an inch between their tips. With these two tips I touched my wife's cheek and asked her how many pencil tips she felt. She felt one. I then touched her finger tip and she had no hesitation in telling me that there were two points. If any part of the body other than the finger were available for reading Braille, it would not have enough tactile discrimination to do it.

### *The sense of pain*

There is a special set of nerves and sense organs for touch. There is another set for heat, one for cold, and still another set for pain. Some years ago when physicians did not make many

blood examinations they took the blood from the lobe of the ear. Now that they make many, they have found the tip of the finger a much more convenient place to prick and, with the pragmatical philosophy of the human race, they say that the blood in the finger is better than that in the ear. Personal experience with both operations has demonstrated to me the disagreeable disadvantage of trifling with pain organs in the finger tips. The existence in the same area of both touch and pain organs may be a cause of considerable trouble when an operation is attempted under local anesthesia. You can explain to an intelligent, well-balanced patient that you will cause no pain but that nevertheless the sense of touch will still be present. Some uncooperative patients, highly nervous, just cannot make this differentiation. Beset with fear, they jump or cry out at every touch. The smart surgeon will be the one to quit under these circumstances and call the anesthetist to put the patient to sleep and remove the mental impediment.

Although the sense of touch is almost always fairly accurately localized, this is not necessarly at all the case with pain. One reason is the enormous number of pain organs. The numbers of touch and pain organs in the skin are 500,000 and 4,000,000, respectively. In the old days when the teeth were not so carefully attended to, it was often difficult for the patient to tell which tooth was aching. It might seem to him that the whole jaw was involved. The dentist might have to rely on his own examination. Despite the extreme sensitivity of the front of the eyeball who can tell where a cinder is resting?

One of the few surgical writings which might be considered classic is John Hilton's *Rest and Pain*, written nearly a century ago. His full phrase was "The Diagnostic Value of Pain" and he showed how careful we must be to interpret pain correctly, with a knowledge of anatomy; and particularly how the anatomy had developed through the ages.

Hilton cited for his first case a man with pain in his ear. Examination showed that he had a jagged tooth and an ulcer opposite it on the side of his tongue. When these were attended to, the pain in his ear ceased. The fifth or trifacial nerve furnishes sensation at both these places and it is rather common for disease in the mouth to send pain shooting up to the

ear. Mr. Hilton found that when a joint was inflamed, the pain might be felt over the muscles that moved the joint, rather than over the joint itself.

The pain of appendicitis usually starts in the mid-upper abdomen, rather than over the appendix. One of our local surgeons used to say, "If the pain starts in the right lower abdomen, it is not appendicitis." Patients with gall bladder disease are likely to experience pain in the right shoulder. Disease of the spine often gives pain in the front belly. In fact, although pain is given us as a protective blessing, and not to mortify us or as retribution for what Great-grandmother Eve did, its tendency to masquerade often makes the task of the diagnostician far from easy.

### *The sense of heat and cold*

The sense organs for heat are distributed unevenly over the body, the face being particularly well provided. Physicians have found that the palm of the hand is especially sensitive to heat. If we suspect inflammation in an area of the body we feel for local heat and we determine this by placing the very center of the palm of the hand over the spot. Lepers unfortunately sometimes lose their heat and pain sensations, and may hold a burning object until their fingers are severely burned. Heat sensation is easily one of our best protective devices.

There are also special sense endings by which we feel cold. They evidently do not give as intense sensations as do those of heat, for it is not uncommon in severely cold weather for perfectly normal people to freeze their noses, ears, or fingers without realizing that they are doing so. Of course, for the degrees of temperature where burning or freezing does not take place, the psychic reaction usually determines the patient's comfort. Perhaps the number of heat and cold receptors may have something to do with this. As I feel comfortable in the outdoor winter weather and very uncomfortable in houses heated and dried as never before in the history of man, perhaps my psyche and collection of nerve endings keep me lonesome in my feelings.

## *Sense organs within the body*

As you may see, all these senses so far described are for relationships with the outside world and are directly or indirectly connected with the skin. There are other sense organs within the body, as those which give us muscle sense, sexual sense, etc. Surgeons find that they may cut the intestine without pain, but if they pull on the mesentery, the membrane which connects the small intestine with the abdominal wall, they cause severe pain. The severe colic often asociated with gall stones or with stones in the urinary tract apparently is due to spasm when an attempt to move them along occurs. The mere presence of these stones is not necessarily painful; many persons carry them to the grave with no suspicion on their part that they possess them.

Evidently there is no pain worse than that experienced when the blood supply to the wall of the heart is suddenly interfered with. It is of a crushing nature rather than a sharp cutting one and is often associated with a fear of impending death. Likewise the patient does not locate it as in the heart itself. I am sure that little is known regarding how all these sensations of the body are received and registered.

Sense organs are small, inconspicuous, and enormous in numbers. In a state of nature it would be impossible to live without them. In an organized society it is demonstrated that none of them is essential to existence, but man cannot live as a social being without them.

# 6. Remote Controls

## VITAMINS

Most of the human body can be seen and studied by the skilled observer with his microscope. But we now come to consider some infinitesimal parts of us, mysterious but so important that they have been discovered chiefly by our startling, sometimes dire symptoms when these tiniest parts are absent or do not function properly. We are a long way now from the times when people believed only what they saw. We can be much more definite and certain than in those days, for any amateur magician knows that the motion of the hand is quicker than the eye, and a legally trained man will tell you that proper circumstantial evidence is more reliable than the testimony of witnesses as to what they saw.

Although the players in this game about to be described are little, they are clever and they have the fighting spirit. Their teamplay would make the Notre Dame squad look like a bunch of sandlot scrubs. We can tell you a lot about their background, what they did in past seasons, and can outline many of their most brilliant plays.

Sir William M. Bayliss in his book on physiology stressed the fact that there are many chemical compounds which are indispensable to the normal activities of organisms, although present in only infinitesimal amounts. He was talking about hormones. Since his day the study of these, along with vitamins and enzymes, has shown that these littlest things are more important even than he surmised. Perhaps it would be well to tell what these three substances are before we consider their activities. A hormone is a chemical substance formed in one organ, and carried by the blood to other organs or tissues on which they act. They have been called "chemical messengers." An enzyme is a complex organic chemical, produced by living cells, which by its presence brings about certain chemical changes — as for example, pepsin, which is produced by cells of the mucous membrane of the stomach. What vitamins are and how they act will be considered in the following pages.

For instance, we are told that Dr. Edward C. Kendall, when he first isolated thyroxine, which is the material that does the work of the thyroid, used six thousand pounds of thyroid tissue in order to get one ounce of thyroxin. Yet, compared with some of the minute amounts that are dealt with nowadays, Dr. Kendall collected an enormous lot. We talk nowadays of milligrams. A milligram is a thousandth of a gram or one thirty-thousandth of an ounce, and I have before me a statement that one man got ten milligrams of male hormones out of seventy-two million milligrams of urine. It seems evident now that a vitamin molecule is part of an enzyme molecule; yet it is believed that a single cell of the body, which is so small that it can be seen only under a microscope, may have many enzymes in it. Some of the metals are also used in minute amounts. It has recently been determined that there has to be some cobalt in order to form vitamin $B_{12}$.

Enzymes seem to be the ultimate agents which do things in the body. We have long talked about the enzymes which digest our food. It has been pretty certainly determined that there are such definite substances, for we know where and how they work. Physiologists feel sure from their observations that there are innumerable numbers of such enzymes through-

out the body. In fact wherever there is life, in or out of the animal body, there are enzymes present. One of the busiest enzymes that you are all familiar with is the enzyme which causes the fermentation of sugars and produces alcohol. Vitamins are necesary to make these enzymes, and hormones seem to be necessary to regulate the work of enzymes in the body.

We know that the body needs small but important amounts of minerals and vitamins besides the long recognized carbohydrates, proteins, and fats. There are lots of these vitamins and they can all be taken in our food and drink, but no one food has them all or even most of them. Hence the dangers of special diets and the sure-fire advantages of well-balanced diets.

The name vitamin is a recent one and it is not a correct one at that. Casimir Funk, who coined the name in 1911, found that these substances are essential to life, hence the first syllable of the name, vit-, as in vital. He then decided that the belong to the group of proteins which is called amines. Mr. Funk was wrong here. The vitamins are proteins, but they are not amines. Nevertheless, it makes a good word and it's here to stay.

Some of the effects of lack of vitamins were known long, long ago. It is over two hundred years since it was first recognized that scurvy is due to a lack of fresh vegetables and greens. A short while after this discovery, Captain Cook, the famous English navigator, made his voyage around the world and by taking advantage of this knowledge kept his men healthy. He also carried a supply of lemons. With the idea that it was limes that were used, the name "limey" has stuck to the English sailor ever since.

What seems to me the best description ever given of a vitamin deficiency was told in Dana's *Two Years Before the Mast.*

> The scurvy had begun to show itself on board. One man had it so badly as to be disabled and off duty, and the English lad, Ben, was in a dreadful state, and was daily growing worse. His legs swelled and pained him so that he could not walk; his flesh lost its elasticity, so that if pressed it would not return

> to its shape; and his gums swelled until he could not open his mouth. His breath, too, became very offensive; he lost all strength and spirit; could eat nothing; grew worse every day; and, in fact, unless something was done for him, would be a dead man in a week, at the rate at which he was sinking . . . . The next morning we spoke the brig *Solon* from the Connecticut River and got from them . . . half a boatload of potatoes and onions. . . . We carried them forward . . . ate them raw, with our beef and bread. And a glorious treat they were! The freshness and crispness of the raw onion, with the earthy taste, give it a great relish to one who has been a long time on salt provisions. We were ravenous after them. . . . The chief use, however, of the fresh provisions, was for the men with the scurvy. One of them was able to eat, and he soon brought himself to, by gnawing upon raw potatoes and onions; but the other, by this time, was hardly able to open his mouth, and the cook took the potatoes raw, pounded them in a mortar, and gave him the juice to drink. . . . This course soon restored his appetite and strength, and in ten days after we spoke the *Solon*, so rapid was his recovery that, from lying helpless and almost hopeless in his berth, he was at the masthead, furling a royal.

The unknown miracle worker then was the now familiar Vitamin C.

A Japanese admiral showed, seventy-odd years ago, that a liberal diet would prevent beriberi, a disease affecting the nerves and heart. Here again the result of a vitamin deficiency and how it could be avoided were known, but no one had an inkling what the cause really was. Not many years later the vitamin deficiency was identified. Yet our doctors in World War II found plenty of beriberi still present in the East. There the peoples, who subsist almost entirely on rice, have learned to their sorrow that they have put their dependence on a slender reed. What an example of human perversity that they should take the trouble to polish their rice and thus lose a life-saving vitamin, part of the B complex. Unfortunately in some places there is no way for the people to learn or to get what they need.

We in this part of the world are lucky that we are able to have about every digestible material in our diet. So, ignorance and poverty are the two chief reasons for vitamin deficiency.

Also foolishness and carelessness occasionally give minor degrees of trouble. The followers of food fads are usually far from hearty. Then we have "bachelor's scurvy." Some unfortunate, living alone, unaccustomed and unskilled in preparing meals, takes the line of least resistance and eats the same inadequate meals day after day. He is not actually sick but he becomes

> A pallid and thin young man,
> A haggard and lank young man,
> A greenery-yallery, Grosvenor Gallery,
> Foot-in-the-grave young man.

All of man's foods — vitamins, proteins, carbohydrates, fats, and some of the minerals — originate in plants. Of course, a lot of what we eat goes through several stages before we get it. A cow munches her grass, works her transformation on it, then we feast on her beef. We, of course, are unable to digest the grass. It seems a little far fetched when our children have to take fish oil to get their Vitamin D, which comes from plant life. But vegetable matter is eaten by the plankton, the plankton is eaten by little fishes, and these in turn are a prey to the big fishes, from whom we get our oil rich in Vitamin D.

## *The different vitamins and vitamin-deficiency diseases*

There is not too much reason in the way we have named and listed the different vitamins. The letters of the alphabet were chosen, presumably because they were short and handy.

Vitamin A is found chiefly in a yellow substance in plants, which we call carotene, especially common in carrots. I feel pretty certain that I have got proper quantities of Vitamin A despite the fact that I am entirely uninterested in carrots, yams, and yellow squash. But nature is kind to us if we cooperate with her. Perhaps my fondness for fish, which contains this vitamin, has helped out here. It is stored in the livers of human beings, as well as of other animals, and therefore we can go for months without fresh supplies of it. One of the main difficulties resulting from the lack of Vitamin A is injury to the vision, especially its manifestation as night blindness. Under normal conditions there is a material known as visual

purple that accumulates in the eye and is important for seeing well in the dark. It is used up rapidly, and we require Vitamin A to develop more.

Vitamin B, to continue down the alphabet, is now known to contain many different substances, so we speak of the Vitamin B complex. Thus beriberi, that the Japanese got from eating polished rice, was due to a lack of thiamine, a part of this complex. Pellagra used to be very common in our southern states, where the poor whites lived on a diet of corn meal, molasses, and pork, and they suffered greatly from diseased skin, diarrhea, and disturbances of the intellect. It is recognized that these were due to the lack of nicotinic acid, also a part of Vitamin B. Only recently has it been discovered that pernicious anemia is caused by the lack of Vitamin $B_{12}$. These are only a few parts of the Vitamin B complex. They all seem to come from plant life, even $B_{12}$ which, you presumably know, sick persons get from liver. Vitamin $B_{12}$ is found in large amounts in the large intestine of cows and there is even a good deal in the human large intestine. We speak of the bacterial flora of the intestine, and flora certainly refers to plants, so evidently we are getting this vitamin in the usual way. It may be a shock to my New England readers to learn that raw clams are said to destroy a large part of their thiamine.

The presence of Vitamin C, or ascorbic acid, was early shown (although what it was, was unknown) to prevent scurvy. One of the earliest workers on Vitamin C was a Hungarian professor, Szent-Györgyi, who managed to extract it from fields of paprika around his home. He thought the substance he got was a sugar and, as he did not know what kind of sugar it was, he invented the name of "ignose," meaning a sugar of which he was ignorant. The editor who published his paper thought that ignose suggested a bit of levity. Szent-Gyorgyi wired back, "God knows."

Unless you are a bachelor, too lazy to get yourself good varied meals, or unless you get caught up in warfare, you are not likely to get scurvy in the West.

An interesting example of how dietary deficiencies can show up in war occurred in the siege of Kut in the First World War, where the garrison was part English and part East Indian.

The Tommies ate bread made from white flour, and also tinned meat and horse meat. This latter contained Vitamin C; so they had no scurvy; but they did have beriberi, due to the lack of another vitamin, the life-saving thiamine, part of the Vitamin B complex, which is refined out of white flour. The Indians, in contrast, ate barley flour which contained thiamine, so they had no beriberi; but because of their religion they could eat no horse meat and thus got no Vitamin C. Therefore they succumbed to scurvy.

Now we come to Vitamin D, which prevents rickets. Bowlegs, swollen joints, and thick skulls, and other manifestations of rickets were common in the early days of my practice. Today, when every child gets cod liver oil or some other fish oil, there is not much of it. Before I went to college, I worked for a while in Boston, and every noon I sat on a stool at a lunch counter. We all wore stiff derby hats in those days which sat tightly on the temples. I had had some rickets in my childhood and I have thick bones there. Every motion of my jaw muscles, with which I chew, caused my derby to wiggle back from my temples. A dozen times during lunch it was necessary for me to pull the derby forward again. So far as I know, that is the only suffering I have ever had from the lack of a vitamin, and I have never bought a vitamin preparation in my life.

One nice thing is that if one gets enough sunshine on the skin, Vitamin D will be formed in the body. For the people who live in the parts of the earth where sunshine is a rarity, nature compensates by furnishing a pretty liberal fish diet. But as I am a fresh air fiend and a sun-worshiper, I am pleased to pass it on to you that authorities say that just giving Vitamin D will not completely compensate for lack of exposure to the sun's rays.

E is the next vitamin on the list. It is spoken of as the anti-sterility vitamin. This idea is founded largely on experiments made on rats. I doubt that there is much importance to be given to it in the case of human beings.

There is one more vitamin which really is important. That is Vitamin K. It plays a large part in the process of coagulation of the blood. It got its letter K because it was discovered by

a Dane and a Dane spells the word with a K rather than a C. Vitamin K is particularly valuable in cases of jaundice. The blood does not then clot well, for the liver is injured and does not manufacture some of the material that normally is concerned in clotting.

I have not given you a list of all the vitamins, and I surmise that new ones will be discovered before you get time to read this.

## *Large doses of vitamins can be dangerous*

Customarily, the interest in vitamins is directed exclusively at insufficient intake, and the question of excessive intake is not raised. But there have been plenty of reports of injury caused by the excessive use of vitamins. Eskimos and arctic explorers have long known that they could be poisoned by eating much polar bear liver. Polar bears live on a good deal of the same kind of food as the fish do. The fish in those cold seas have large amounts of Vitamins A and D stored in their liver. Patients in our warmer climates have been injured by large doses of these liver oils. Doctors have a good deal of difficulty in recognizing these cases of hypervitaminosis. In the first place, the signs and symptoms do not appear for a long while after the vitamins have been taken. Then the patients begin to itch and have lack of appetite. They notice tender swellings in different parts of their body and find that there is limitation of motion in their joints. It is usually children who get these vitamins. If the trouble is suspected and the parents are quizzed about it, it is found that they have been giving their children larger doses than have been prescribed. They have the delusion common to almost everybody, even to doctors, that if a little of something does good, more of it will do more good.

Probably you have forgotten by now the article in one of the most spectacular of our periodicals, telling how arthritis could be made well by large doses of Vitamin D. That article made a lot of trouble, as was demonstrated in a meeting of the American Medical Association a few years ago, where horrible examples of bone changes, following this abuse, were shown.

Patients who get too large doses over a length of time lose calcium from their bones, but strangely enough there may be great deposits of calcium in the tissues where they do not belong. The patients really feel sick; they are sick at their stomach. They have urinary frequency and diarrhea, lots of pain in their intestinal canal, and often vomiting. The trouble may go on and even result in death. The treatment is simple enough, and gives good results when taken early. It merely consists in seeing that they do not get Vitamin D or much calcium in their diet. Take the patients off their high vitamin regime, and nature does the rest, if too much harm has not already been done.

### *A balanced diet provides all the vitamins you need*

One of the most remarkable phenomena of modern times has been the sale of vitamins to the American public. A friend of mine dwelling on the outskirts of New York City told me that an astute businessman came into his town with a lot of ready money, bought up large stocks of vitamins, and began a tremendous advertising campaign. He also brought over from Europe several smart investigators, who were evidently financially embarrassed. They went to work in the laboratory and every favorable report from them went into the advertising. The rest of their work was ignored.

The American public has been spending many, many millions of dollars a year on vitamins. It is said that the money so spent has been equal to the combined sales of laxatives, dentifrices, and hair tonics. I should say that every article on vitamins that I have seen, which gave evidence of careful investigation, has pointed out that most of the ways in which vitamins are used are foolish. Vitamins are tremendously important, but they come in foods; the well-balanced diets that Americans are easily able to get furnish these vitamins in proper amounts and at the same time furnish the proper nourishment. Why is it then that physicians prescribe so many vitamins? Well, physicians are also susceptible to the hammering effect of clever advertising. As Bernard Shaw and other people have pointed out, physicians, to hold their patients, at times have to give

their patients what they want, and they are going to do it if they feel that they are not actually harming their patients. The effect of vitamins is a long-range one; practically never does a vitamin deficiency occur in a short-term illness.

Somehow man has managed through eons of time to find food to nourish himself, although often handicapped by scarcity. When supplies were abundant, he has instinctively partaken of a varied diet and although ignorant of its components has got what he needed, including vitamins and minerals. Ignorance, shiftlessness, and poverty were the obstacles in the past in certain communities, leading to the spreading of hookworm and anemia.

These poor unfortunates unknowingly brought the troubles on themselves. In the parts of this country, where we smugly admit that we are more advanced, there are areas, such as that near the Great Lakes, where many persons develop unsightly lumps in the neck, enlarged thyroids called goiters. These people are dull; some of the children are idiotic dwarfs. Near the seashore goiters are rare, because lack of iodine is the scapegoat and there is plenty of iodine in sea salt. Of course even the inlanders use salt. But here is a case of man's inhumanity to man. We fortunate ones want our salt "refined." We want it to look nice and to contain none of the other sea materials which might offend our palates. Or at least the dealers tell us that we want it so and also packaged in pretty containers at a special price. So the iodine has been extracted; now it is being returned.

As man has approached what we call civilization, he has become finicky, and done many things to make his food what he considered more palatable. There is danger when this tampering is done blindly. It has been said that Americans boil their vegetables so long that they would do better if they drank the water and threw away the rest. Thus they would get the minerals and possibly more of the vitamins and carbohydrates. Modern diet is often similar to that described by Demosthenes: "Like the diet prescribed by doctors, which neither restores the strength of the patient nor allows him to succumb."

Early in the nineteenth century a remarkable and pictur-

esque man convinced himself and many others that the milling which produced white flour left something out. We know now that it was part of Vitamin B, but we are a century later than he was. This zealous reformer, Sylvester Graham, born in Connecticut shortly after the American Revolution, was ordained a Presbyterian minister, but he became famous as a lecturer on temperance and dietetics, strongly advocating a whole-wheat flour named graham after him.

His cult was so popular that his followers were referred to as Grahamites. Easily one of the most famous of these was Lydia Pinkham. (We doctors think that if she had stuck to dietetics and left gynecology alone, she would have done much less harm.) There were many Graham boarding houses in the country where his theories were zealously adhered to.

But, as is usual with ardent reformers, there were those who took him with a large pinch of salt. Ralph Waldo Emerson referred to him as the "poet of bran bread and pumpkins." Graham's fame was widespread, for he was an exceedingly popular lecturer. He also had a cure for alcoholism which he based upon a vegetarian diet. However, he is still famous today largely because of his lectures on the science of human life, and especially because of his book on *Bread and Bread Making*. He most certainly was correct in his belief that whole-wheat is better than white flour, and today we continue to eat graham bread and graham muffins.

The vitamin-supplying vegetables, fruits, and cereals are now used freely as they were not in Graham's day, a big improvement in diet. The modern prevalence of pure drinking water is also one of the greatest advances since his day, but few people drink enough, particularly women.

Graham was in full accord with that wise man, Samuel Johnson, in advocating cheerfulness at meals. Johnson said that kindness is better promoted, "where there is no solid conversation." It was for this reason Sir Robert Walpole said, that "He always talked bawdy at his table because in that all could join."

The millers of Graham's time were removing a certain part of the grain in order to obtain a flour that could be easily stored without becoming rancid. This flour was white, and by

clever publicity the public was led to admire whiteness. Now that the home use of flour has almost ceased, so has that advertising. But the modern interest in vitamins has once again aroused the forebodings that Graham had and the bakeries are "fortifying" their white bread.

This is the great modern paradox. Few words connected with health are better known that "vitamins." Everybody is convinced that the body needs lots of them. At the same time food is being processed so that there are less and less vitamins in it. And there is more and more consumption of vitaminless materials: soft drinks and ice cream, for instance. Until a few years ago no man ever took a vitamin pill. Today soap manufacturers sell them in astounding quantities. Euclid said that there is no royal road to geometry. So it is with health, but the multitude seem to be convinced of the opposite. They ignore the comparitively inexpensive balanced diets and spend vast sums for the magic multivitamins. But the Lord is good to us. There are lots of vitamins around and the amounts needed are minute. Most of the population get what they need and, although they waste a lot of money, that is not serious under modern economic conditions.

### *Vitamins build up enzymes*

It should be evident that vitamins are food. Food builds up the body or is used to furnish energy. It would seem that the part of the body built up by the vitamins is neither muscle, bone, nerve, nor any of the other tissues but some mysterious, minute gold dust twins, called enzymes. Nobody has ever seen them, but we know from the results of their work that they have been around and have been very busy. There are no live activities without them. Their number must be practically infinite; each has its own special task and does no other task. One thinks of the workers on an auto assembly line where one man screws up certain nuts and bolts. It is a small part of the complete job, but if he does not do it properly, the auto performs poorly if at all. Enzymes run the body assembly line.

When I said that nobody had ever seen the enzymes, I was

referring to the vast majority in the cells of the body. A few of them, notably the enzymes of the digestive tract, as, for instance, the pepsin of the stomach, have been isolated and collected. But to identify them all would be like cataloguing the stars. The better our telescope, the more stars appear. The biological chemist knows that the number of enzymes he becomes aware of depends only on the amount and complexities of his studies. Vitamins help to build these enzymes; now let us see how hormones help to control them.

## HORMONES

Everybody knows what a hormone is; that is, everybody except the scientists who try to study them. The reading of a book on hormones is very hard going as the author continually has to acknowledge the limitations of his knowledge and qualify his remarks accordingly. Thyroid extract, ovarian extract, cortisone, and numerous other kinds of "gland" extracts are hormones. The simplest explanation is that a hormone is a chemical substance which, having been formed in one part of the body, is carried in the blood stream to another organ or tissue and influences its activity.

There are many glands in the body and they consist of a cell or a collection of cells which select from the blood or build up materials which they then discharge. A familiar example is found in the mouth, where the glands discharge saliva. These glands have ducts, or tubes, through which their fluid flows. They are called exocrine glands (*ex*: out). The endocrine glands (*endo*: within), however, do not have any ducts. Their secretion enters right into the blood as it flows through them. These latter secretions are called endocrines, or hormones.

These substances are catalysts. Catalysts are common in chemistry. They cause special chemical reactions to take place but they, themselves, are not used up. Hence only minute amounts of them are necessary. It strikes me that an excellent example of a catalyst is the boss over an old-fashioned gang of street laborers. He does none of the labor himself and yet it would cease but for his presence.

The action of the first type of gland (exocrine) is not so greatly different from what goes on in the kitchen or chemistry laboratory. The pancreas, like the salivary glands, has a duct and it pours out its secretions through this. The intestine represents the beaker where the chemical reaction with the food takes place. For a long time this was thought to be the only function of the pancreas.

But in the last century scientists began to realize that there were more mysterious affairs going on in the body than these laboratory or kitchen procedures. First it was discovered that, if the pancreas is removed, much sugar is found in the blood and urine; and later it was shown that this results from a lack of insulin, which is secreted by the pancreas, not through the pancreatic duct but directly into the blood stream. This was the first great practical result from the study of endocrinology; still the most important because of the frequency of diabetes. But even before this the relation of certain bodily disorders to abnormalities of the adrenals, the pituitary, the thyroid, and the testicles had been noted.

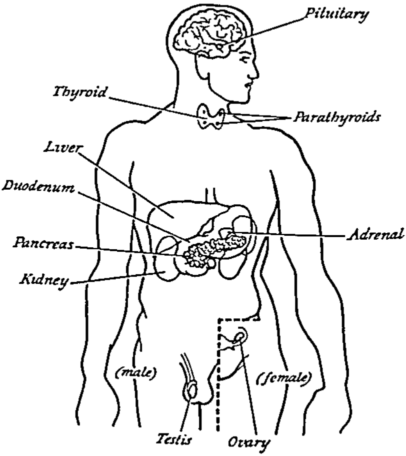
It is convenient to discuss the body as composed of a number of individual systems, but they are of course able to function only by elaborate teamplay. It is the special function of the hormones, secreted by the endocrine glands, and of the nervous system to transform your exceedingly varied collection of tissues and organs into a cooperative enterprise. The hormones prepare you in advance for a good fight by regulating your everyday activities. They oversee the changing of food into good tissues, regulate your growth and the production of offspring. In doing this they are helped by certain portions of the nervous system. But in emergencies the nervous system acts quickest. If you are attacked by a thug, your nerves tell you to duck and hit back. Your hormones almost as quickly jump up all your immediately necessary activities and release extra energy.

It is advisable, even necessary, to discuss the better-known glands of internal secretion separately, although the hormones interact, blending together like the instruments of an orchestra to make a perfect symphony. The pituitary is often spoken of as the conductor of the hormonal orchestra. The metaphor is

a reasonably good one although the loss of only one player in this orchestra will usually disrupt the playing.

## *The pituitary gland*

Of all the intricate, complicated organs of the human body possibly the pituitary is outstanding. On the inside of the bottom of the skull is a bony formation called the sella turcica,




Approximate locations of the chief endochrine glands in man. (*After C. D. Turner,* General Endochrinology, *p. 9. W. B. Saunders Co.*)

which is Latin for a Turk's saddle. It reminds us of the American western saddle. Seated here is a little mass of tissue half an inch long and a quarter deep. It is divided into an anterior and a posterior lobe.

When the embryo is developing, the anterior part of the pituitary forms from the lining of the mouth; and the posterior part, from the brain. Thus one might naturally suppose that the pituitary would have two functions; as a matter of fact, it has, according to different investigations, ten or twenty in the anterior lobe alone.

Dr. Harvey Cushing (1869–1939), the founder of brain surgery in America. This portrait by Dean Keller shows him making his notes immediately after an operation.

One of its chief jobs is to regulate growth. If one of the secretions from the anterior lobe ceases to work in childhood, there results a dwarf. Usually these dwarfs are well formed and relatively normal except for their size. If something, such as a tumor, causes an overabundance of this secretion, then the person becomes a giant. These individuals are usually big but not strong. If the increase of secretion does not occur until growth is complete, a condition known as acromegaly gives an

enlargement of parts of the body: big hands and feet, jaw and brows.

The fat lady of the circus also has trouble with her pituitary. You don't have to be convinced that people can get very fat just by indulging their appetite for food, but even one of these won't qualify for side-show jobs unless the anterior hypophysis cerebri, which is our pet name for the front part of the pituitary, is diseased. Closely related to this is another disturbance, described by the late Dr. Harvey Cushing, of Boston, and this is a complex affair. It disturbs the growth and the blood pressure and the sugar in the blood, and changes the sex characteristics so that women are more manlike than normal, and the men are less so, and all are enormously fat — a mixed-up bunch of troubles. I could tell you more of the disturbances of the anterior lobe of the pituitary but this is enough to suggest the complexities.

Another disease of the pituitary (this time the posterior lobe) is called diabetes insipidus. In this, the patient passes enormous amounts of urine and therefore has to drink corresponding amounts of water. You can see that this interferes with digestion and makes it difficult to control the heat of the body. You have been told that sweating is the chief method for controlling the body temperature. I have known a man with pituitary trouble which affected his heat-regulating mechanism so that he never sweated. He had much disturbance in hot weather because he was always in danger of a heat stroke – he had no sweat to evaporate and thus remove his bodily heat.

The posterior lobe, so far as we know, is a much simpler apparatus that the anterior. It is derived from the brain and is therefore mostly nerve tissue. An extract of this lobe was obtained over fifty years ago and was probably what was mostly used by a few misguided doctors who treated their patients with "pituitary."

There are some very definite uses for this posterior lobe extract. It does stimulate smooth muscle. Perhaps you remember that most of the muscles of the body, those that you are well acquainted with, which, as willed by us, do our so-called muscular work, are striated muscles. (Little grooves or bands

run across the fibers.) But in the blood vessels, the intestines, and many other parts of the body, there is plain, or, as we call it, smooth muscle that works all the time without our even knowing it. For instance, our food would not move along our intestines were it not for this smooth muscle. Therefore physicians at times use pituitary extract to stimulate these smooth muscles, as for example, when they feel certain that there is no actual obstruction in the intestines but that the muscles are lying down on the job.

The smooth muscles of the uterus also may be stimulated by this extract. When labor is long delayed and the obstetrician feels that the contractions should be increased, he may use this extract of pituitary. Needless to say, there are plenty of opportunities for trouble when one is interfering with the action of the intestine or uterus, for example, so these powerful extracts have to be used with great caution.

Although the presence of the pituitary was known to men centuries ago, they had little accurate knowledge of it, as is shown by their giving it a name referring to nasal secretions. There have been recited above some of its actions, but our information about all of these things is still vague. You can imagine that a mass of soft material, the size of your finger tip, divided into three parts, situated close to the bottom of the brain, at about the middle of the skull, and producing possibly a score of hormones, does not lend itself to accurate appraisal.

Still for a long while, extracts from the posterior lobe have been used, and numerous hormones from the incredible anterior lobe have been recognized and some isolated. They have effects on growth, stimulate the sex organs, cause the breasts to enlarge and produce milk, and they influence diabetes. More recently a hormone which acts on the adrenal glands, known as the adreno-cortico-trophic-hormone, or more familiarly as ACTH, has been shown to have very important effects on various abnormal conditions. It causes the adrenals to produce large quantities of the secretion of their outer layers or cortex. These secretions have been carefully studied and their chemical nature is known. They have very profound effects on the processes of inflammation in the body and have proved to be very important and powerful substances which must be used

with great caution; for, like most effective medicines, they can do great harm if wrongly applied. (They will be further discussed under adrenals.)

Another important hormone from the anterior lobe, is called the thyrotropic, and stimulates the thyroid, which in contrast to the pituitary, is readily accessible and of such size that even when not overgrown it may be easily handled surgically.

## *The thyroid gland*

In the front of the neck, running across the windpipe just below the Adam's apple, and with a lobe on each side, is another endocrine gland, the thyroid. In most people it cannot be seen or felt. However, many a young woman owes her nice full neck, a very attractive feature, to a little enlargement of it, which is called an adolescent thyroid. This usually produces no symptoms and does no harm.

Apparently the most important material for the proper functioning of the thyroid is iodine. In certain parts of the world, as for instance near the Great Lakes and in Switzerland, where there is a lack of iodine, there are a great number of goiters, or enlarged thyroids. (The term "goiter" merely means enlarged thyroid). These are uncommon along the seashore for iodine is abundant there. In fact the early method of obtaining iodine was to burn seaweed and extract the iodine from the ashes. The goitrous thyroids, although large, really contain small amounts of the active thyroid tissue.

In goiter districts there are many cretins; that is, children born with deficient thyroid glands. They are uncouth, poorly developed dwarfs with subnormal intellects. If they are started early in life with proper doses of thyroid extract, they will usually develop well both physically and mentally. I know few things in medicine more striking and gratifying than to take one of these unpleasant-looking infants, photograph it for record, begin thyroid treatment, and see it bloom in a few months into a perfectly respectable-looking child. Unfortunately the underdevelopment of the thyroid is a permanent matter and thyroid treatment must be continued throughout life.

It sometimes happens that in persons who have developed naturally, the thyroid function later drops to below normal. This is known as myxedema. There is usually some anemia, the hair is coarse, the skin dry and inelastic, and both mentally and physically the patient slows up. The first such case to be treated with thyroid extract was reported in the *British Medical Journal* in 1890. One or two years later a woman in this country was found to have myxedema. She also was started on thyroid extract. Some thirty or forty years later I saw her for another trouble. She was a lively lady of ninety-odd, despite the fact that she had also had a very high blood pressure for many years.

The commonest abnormality of this organ, in our part of the world at least, is an overfunctioning called hyperthyroidism. Many of these people have an enlargement of the gland and a bulging of the eyes, and hence are referred to as cases of exophthalmic goiter. Whether or not the patient has these eye signs or a swelling of the gland, the important part is that there is too much of a good thing going into the body. That, of course, is the iodine compound which the thyroid makes. Just as the accelerator on your auto allows extra gas to flow, thus speeding up the engine, so the thyroid lets extra amounts of its secretion into the blood and this speeds up the body's activities. The chemical changes taking place in the body, producing energy and building up tissue, are given the name "metabolism." When too much thyroid extract causes these metabolic changes to take place too fast, the results are nervousness, loss of weight, excessive sweating, fast pulses, shaky muscles, etc.

**Means of studying the thyroid gland.** When this condition is suspected, a helpful means of diagnosis is the estimation of the B.M.R., basal metabolic rate. In the past a number of investigators did years of laborious, elaborate experiments on many voluntary subjects before there was collected the information by means of which these patients now are studied. In this way it was determined what might be considered the "normal" rate of metabolism, when no heat or energy is being produced by food or exercise, but all the heat generated by the individual is due to the activities of the resting organs and

tissues (heart, blood vessels, muscles, glands, etc.). Many factors were found to influence the rate of metabolism, such as age, sex, height, and weight. Females in general have a lower rate than males; the young have a higher rate than the old. Any object warmer than its environment gives off heat, not in proportion to its mass, but in proportion to its surface area. As objects decrease in size, the proportion of surface to bulk increases. Thus a mouse has a much higher rate of metabolism than an elephant.

Now it is possible to use comparatively simple apparatus and cause little disturbance to the patient's routine while studying him. Oxygen is always a factor in the processes of metabolism, so the estimations are made by the amount of oxygen consumption under carefully regulated conditions. Digestion influences the rate of oxygen use, so a prescribed diet is given the night before and the test made in the morning under fasting conditions. Physical activity, the warmth and comfort and general state of nervousness of the patient are carefully regulated.

It is, of course, evident that all these matters are far from being easily controlled and fluctuations in the results obtained are to be expected. Therefore a number of readings are made and the average of them used. As has been said before, "normal" figures have been set as a result of extensive experiments and the results of a test are put down as plus or minus in relation to them. This is called the basal metabolic rate, abbreviated to B.M.R.

There are a few highly important causes for the changes in the B.M.R. Fever raises it; typhoid sometimes brings it up 40 per cent above normal or more. Under-nutrition or starvation lowers it. However, the one pre-eminent cause for constant deviation in the basal metabolic rate is a change in the activity of the thyroid and it is in thyroid disease that this laboratory procedure assumes a leading role in diagnosis and the regulation of treatment. The basal metabolism apparatus and the information derived from the use of it are a triumph of modern research but it must always be borne in mind that the value of the information is to be measured solely according to the skill and judgment with which it is used by an experienced physician.

Naturally physicians have desired some test of the thyroid's function which would be simpler than the basal metabolic rate, which has always had to be taken with a grain of salt, metaphorically speaking; certainly not physically. One of the latest of these methods is the measurement of the up-take of radioactive iodine by the thyroid gland. You have all read in the daily press that when any material is bombarded by the tremendously powerful rays such as are developed in the atomic energy plants, some of the atoms of the material become radioactive and their presence can be determined by a Geiger counter. Despite this remarkable change, the material works chemically as it did before. Iodine which has been so treated can still be taken up by the thyroid and will perform its functions as usual; however, it can now be determined how much iodine has been absorbed and as the activities of the thyroid depend on iodine, the amount of iodine taken up will give an index of the activity of the gland. At present this examination is often done indirectly by measuring the radioactive iodine in the urine.

The thyroid hormone. The active material which the thyroid manufactures and secretes is called thyroxin. The normal individual uses just enough of the thyroid hormone for his needs, neither too little nor too much. Right here we see again the teamwork of the hormones. One of the hormones that the pituitary secretes regulates the working of the thyroid. Therefore it occasionally happens that when a disturbance manifests itself in the thyroid the real seat of the difficulty may be in the pituitary. You may imagine that this complicates the handling of the case.

However, in nearly all cases the situation seems to be confined to the thyroid and can be taken care of there. The treatment has always been to cut down the amount of thyroxin. This has been done in an enormous number of cases by removing a part of the thyroid gland. In order to get the patient in the best condition for surgery a form of iodine used to be given. In recent times newer and better agents have been used which cut down the amount of thyroxin. Occasionally this treatment itself has been sufficient but so far it has been used mostly as a preliminary to surgery. Naturally, in this atomic age treat-

ment by radioactive iodine is being used; for if enough radioactive iodine is absorbed by the thyroid, much of the active tissue of the gland will be destroyed by the radiations. This is hopeful but we will have to wait and see.

## *The parathyroid glands*

It's the little things that count; this trite observation is brought home to us by the parathyroid glands. In the tissues, closely attached to the thyroid, are some tiny seeds, usually two on a side, one quarter inch in diameter and difficult to see even when they are being searched for. These parathyroids have much to do with regulating the calcium and phosphorus in the blood. The calcium is said to constitute 2 per cent of the body weight; 99 per cent of this calcium is stored in the bones. Nevertheless it circulates in the serum of the blood and the amount here has to be carefully regulated.

The obvious thing about calcium is that it is great building material. The mortar of brick buildings, the shell of the oyster, and the bony structure of our body—calcium furnishes their strength. But when these break down or lose their usefulness they clutter up things and are a nuisance. And nowhere so much a nuisance as in the human body. Thrown away calcium may form kidney and bladder stones. Still worse and happening more frequently are the deposits of calcium in the blood vessels, causing arteriosclerosis.

Fortunately the insignificant little parathyroids and the minute amount of calcium circulating in the blood, about one four-thousandth of all there is in the body, can pull many fast plays and they seldom go wrong. Bulk is not so important in the human body as on a modern football field. The parathyroid secretion directs the plays and makes the passes. The calcium does the scoring. But it has help, as all spectacular players do. It was said above that the parathyroids regulate the phosphorus in the blood. To add to the metaphorical mélange I will quote Dr. W. S. Hoffman: "Equally fascinating —but often ignored because of the glamor of its partner, like the male member of a dance team—is the role of inorganic phosphate." You see, all substances in the body act as com-

pounds; sodium chloride, (salt); $H_2O$, a compound of hydrogen and oxygen, (water). And there is something else without which calcium cannot do its work, Vitamin D, procured from sunshine and found in cod liver oil and elsewhere.

Calcium is necessary for the coagulating of the blood; so it keeps us from bleeding to death. No mean feat. Its most striking effects are on the muscles and nervous system. These, unfortunately, can be demonstrated to us only when there is an excess or a deficiency, and fortunately these situations are uncommon. If a surgeon when operating upon a thyroid inadvertently removes the closely attached parathyroids or destroys their blood supply, a condition called tetany occurs as a result of insufficient calcium in the blood. The muscles go into spasms and other unpleasant signs appear. Milder evidences may result from lack of Vitamin D, or alkalosis, which latter is the opposite of the much talked-about and fairly uncommon acidosis.

Occasionally tumors grow in the parathyroid glands, causing an overdose of their secretion and making the proportion of calcium in the serum of the blood high. In order to keep this calcium high, the body has to remove it from the storehouse in the bones. As it is calcium which gives bones their stiffness and strength, the result is bad.

If every organ of the body behaved as do the parathyroids, life would be easier for us. Tiny as they are, it is not surprising that they were not discovered until 1880. Thirty years later Osler's *System of Medicine* made no mention of their diseases. How different is the history of the next gland to be described.

how much space is given to this learned physician and how much to a bunch of fighting men or politicians. But don't look; he isn't mentioned.

Not much was known about the adrenal glands until three hundred years after this, when Thomas Addison, of Guy's Hospital, London, in a short paper told of a disease which was due to trouble in the adrenals. Few scientific writings in all history have contained so much in so little, for in forty-six pages he also described what has been called pernicious anemia, or Addison's anemia.

A few years ago I dropped into the hospital and heard a brilliant young intern present a case of Addison's disease of the adrenals. His story was indubitably one of the "fairy tales of science and the long results of Time." Addison showed that a well-known combination of signs and symptoms was always due to destruction of the adrenal gland. There is anemia, weakness and languor, feeble heart action, irritability of the stomach, and—most characteristic and striking—a bronzing or dark discoloration of the skin.

These patients also have a great craving for salt, which is reasonable for they actually need the salt. If Addison's disease is suspected but not proved, a method for detecting it is to bring the patient into a hospital and put him on a salt-free diet. Hospitalization is important, for the withdrawal of salt may make the patient who has this disease very sick, and treatment has to be prompt and efficient. Salt solution must be put right into the veins and the patient given a hormone to take the place of that which the injured gland cannot supply.

Extract of the adrenal gland was formerly used, but the drug houses manufactured a substitute with the more than mouth-filling name of desoxycorticosterone acetate. One glance at this name would convince you that it could not be swallowed to advantage. Therefore it was put into oil and injected into the muscles. There is a great drawback to this treatment: one dose lasts only twenty-four hours. Nowadays you all have had repeated injections and can appreciate that these sword thrusts into your buttocks would indeed furnish a painful basis for existence.

A few years ago Dr. George Thorn, of Johns Hopkins, now

of Harvard Medical School, developed a method that avoided these recurring unpleasantnesses. The substance with the long name can be formed into pellets. A short incision is made in the small of the back and the pellets placed deep in the tissues. Here they slowly dissolve, the body takes up the amount of substance which it needs, and with proper regulation of the amount of salt the patient needs no more pellets for a year at least. This method is still being used but also, probably in more cases, an injection of related substance which absorbs slowly may be used once a month, thus obviating a somewhat elaborate procedure. We have here a formerly hopeless condition, understood for about a century, recently made amenable to treatment and now dominated by simple procedures.

Addison was sixty years old when he published his great work—a striking exception to the commonly held belief that original work has to be done by the young. It is interesting that he, one of the brightest and most capable of physicians, never had a large lucrative practice. This was due, undoubtedly, to the fact that he had a haughty, repellent manner, which, on his own showing, concealed excessive shyness.

It is not merely his identification of two well-known diseases that makes Addison great. It is said that the whole of endocrinology, or the study of hormones, dates from March 15, 1849, for from that date it has been realized that disturbances of these secretions can cause disease.

Adrenalin, the hormone of the medulla. The adrenal is really two glands: the central core called the medulla; and the surrounding shell, the cortex. The hormone from the medulla, called adrenalin or epinephrin, was the first hormone which was extracted in a crystalline form. Now the drug houses do not bother to get it from animal tissues, but make it chemically. All animals have it in varying degrees and it may intensify your fellow feeling for animals to learn that a toad in Jamaica has in its parotid glands four times as much adrenalin as a human being has in the whole body.

The body uses this secretion for emergency measures. Dr. Walter B. Cannon, the great physiologist of the Harvard Medical School, described what has been called the "alarm reaction." When an animal meets a situation arousing sudden anger or

fear, the medulla of the adrenal pours out its secretion to aid the animal in fight or flight. This secretion causes the heart to beat faster, pumping more blood; the saliva and digestive juices stop secreting as they are not needed for the time; the muscles are made tense and ready for quick work. One important effect is the freeing of blood sugar in the liver so that it may be "burnt" and provide quick energy. Recently it has been shown that this secretion is made up of two related substances. One of these acts to raise blood pressure and is used in the emergency treatment of conditions in which the pressure has fallen to a dangerously low point (as occurs in serious injuries and in a certain type of heart disease). All these and other things are done by the adrenal medulla. Later the cortex begins to aid in the work.

A generation or so ago a writer of popular dog stories explained in terms of the above his ability to get along with ugly dogs. According to his theory, persons who fear such dogs pump out adrenalin, which causes a bodily odor detected by the acute noses of the dogs. The animals, unable to differentiate between this fear and anger, work on the theory that the best defense is a quick offense. The dog lover's placidity frees no adrenalin; hence no bodily odor suggesting anger; hence no trouble with the dog.

Dr. George Crile, a famous surgeon of Cleveland, followed up the idea of Dr. Cannon and formed a collection of adrenal glands of many animals, including the big game which he shot in Africa. His theory was that those animals capable of sudden, intense, short-lived activity have large adrenals, owing chiefly to the unusual size of the medulla, which excretes adrenalin. In his museum, which he kept in the headquarters of the American College of Surgeons, were models and stuffed specimens, lifesize, and alongside each was shown the actual size and shape of the adrenal. Thus a thoroughbred race horse has an enormous one while a Percheron, a huge draught horse, possesses a minute one. A lion's is big, an alligator's tiny. The mouse, an exceedingly active little animal, has an adrenal only slightly smaller than that of the huge lumbering elephant.

**The hormones of the cortex.** All the above has to do with the medulla (or core of the adrenal) and its secretion. Out-

side it, the cortex, or shell, is credited with having about thirty hormones. Probably the count has increased by now. One has to do with the handling of the salt of the body. Another has an effect on the secondary sexual characteristics. Its absence will cause a woman to be masculine in appearance and a man to have feminine attributes. Finally, another hormone deals with the carbohydrate of the body. Thus you see that the adrenals are closely associated with the pituitary, the pancreas, and the sex glands.

A great deal of investigation has been made on the cortex or outer shell of the adrenal, which, you remember, is really a separate gland from the medulla, or core. The substances formed here are known chemically as steroids. They are complicated in structure, but the chemists can draw diagrams and talk glibly of seventeen keto steroids. At some of the seventeen different carbon atoms on these great molecules, the chemists can add on or take off and thus get substances with different qualities. Some of these are the hormones of the adrenal cortex or at least are very similar to them.

These hormones are in three groups:

1. Controls the sodium and potassium which are necessary to the body. This hormone also has to do with blood pressure.
2. Influences the carbohydrate or sugar of the body.
3. Controls the secondary sex characteristics. They make the man masculine with his beard and heavy voice, manly build and other typical appearances. And they give the woman enlargement of the breasts, a high-pitched voice, female curves, etc. Apparently all these hormones have some of all these qualities but in greatly varying amounts.

*Cortisone and ACTH.* I will take up the second group because all of you have recently heard much about this particular type of hormone since Drs. Kendall and Hench of the Mayo Clinic announced the discovery of cortisone. Now hydrocortisone, or Compound F, and other associated compounds have been developed. These have much the same effect as cortisone but are apparently more effective and can be handled in simpler ways. Presumably ACTH is also familiar to you. The

letters stand for adreno-cortico-trophic-hormone, and mean—a hormone which influences the cortex of the adrenal. This is a striking example of the teamwork which you have been told distinguishes the hormones.

ACTH does not itself work in the body much, but it stimulates other hormones to work. An illustration shows how it joins to help when an animal or a man is attacked or angered or frightened. The first reactions are given by the nerves, causing a reflex dodge or a quick blow, and notifying the medulla, or central part of the adrenal. This endocrine gland quickly secretes adrenalin, causing the immediate bodily reactions that were described above. But the brain has also been notified and sends word to the pituitary. The pituitary discharges ACTH into the blood which carries it to the cortex of the adrenals. Here its prodding causes the hormones of the cortex to be secreted. I should say that they carry on from where the adrenalin leaves off. They overcome the inflammatory effects of many sorts of damage to the body and diminish such effects in the joints injured by rheumatoid arthritis, the hearts suffering from rheumatic fever, or inflamed eyes.

You must remember that cortisone and its related compounds are substitutes for the hormones of the adrenal cortex. ACTH bestirs the hormones and drives them to their work. So you can see that there are two ways of tackling some of these associated problems. Method number one—give ACTH to stir the adrenal cortex up to do more work. Method number two—give a hormone of the cortisone family to do the work. There are a thousand complications. I think that you and I should be satisfied with these few generalities.

The administration of these substances causes some changes in the bodily activities which are not desirable and which have to be guarded against during treatment. Some of these changes are the natural result of unusual amounts of the hormones. Some may follow because there is not perfect purity of the materials. The removal of thousands of pituitary glands from thousands of animals in slaughter houses cannot be too accurately done and so ACTH is contaminated with some of the posterior portion of the pituitary.

ACTH through its stimulation of the adrenals has some effects which are very undesirable. It prevents inflammation.

You can all recognize inflammation if it is where you can see it. There is swelling, redness, heat and pain. They seem disagreeable to you but they are nature's way of fighting disease. If a patient taking ACTH has pneumonia, all the ordinary signs by which a physician recognizes the disease may be absent and yet the bacteria may be in the blood or tissues and doing harm.

Cortisone of course has similar bad habits. For one thing it increases the activity of pepsin in the stomach and interferes with the healing process and this is bad for an ulcer. Yet the patient isn't bothered by the ulcer. He has what a young physician calls a "concomitant euphoria." This is our snappy way of saying that as the trouble gets worse the patient feels fine. Strangely, in the trouble which is lower down, that is ulcerative colitis, cortisone may be helpful.

Although these agents help in many ways, it should be remembered that a fairly common consequence of hormone therapy is to lower resistance to infection. Thus the presence of cortisone in the body has a tendency to revive an infection or to prevent healing. One of my non-medical friends, who suffered from gout, browbeat a young doctor and got a supply of cortisone. When he felt an attack coming on, he took some of the hormone. Result—immediate and miraculous relief of his swollen, painful big toe. In no way connected with this, he soon had to have his prostate removed. But, just as he was going home a few days later, his surgeon noticed that he was getting edematous (he had abnormally large amounts of fluid in his body). His wound was also breaking down. It took three weeks in the expensive hospital to straighten out his cortisone difficulty.

There are parts of the human body far more delicate than the purse strings. If a big, dangerous operation is to be undertaken on a patient who has had cortisone, it is necessary to prepare him with great care. As cortisone is a substitute for normal adrenal hormones, the gland, since it has not had to work, "lays down on the job" as it were, and afterwards remains slothful. Should the surgeon unwittingly operate without furnishing adequate cortisone, the result for the patient may be severe shock or even sudden death.

Writing scare stories is not my forte but you must be warned.

Upsetting hormone balance is a serious matter, with nervous as well as other reactions. People have even been driven into severe mental diseases by cortisone. You know that with surgery death is frequently near to the surgeon's knife. Some of our new miracle drugs put fully as much responsibility on the medical man.

But I don't want you to forget that these new agents are most decidedly helpful in a number of diseases. The other day at the hospital a film was shown by a large drug firm which manufactures cortisone. It illustrated the general principles of its use and its good effects in proper cases.

A boy had been hit in the eye by a baseball bat. There was inflammation both inside and outside the eyeball making a very bad-looking condition. Perhaps the eye would have got well anyway but there was a chance of permanent injury if the inflammation persisted long. With atropine and cortisone dropped in the eye he quickly improved and was soon well. But I do not believe that every black eye should be treated with cortisone.

There is a skin condition in which blisters appear over the whole body. It is very chronic and may result in death. The case in the film was treated with cortisone, improvement soon began, and the patient was evidently tided over a serious situation. This was not the first time that she had been so treated and very probably she would need treatment again sometime.

A six-year-old boy was evidently very sick with rheumatic fever. With cortisone and other proper heart treatment he soon showed great improvement. Here was a youngster who was in immediate grave danger if his acute attack of rheumatic fever was not quickly controlled. Now his chances of handling his disease are greatly improved.

Rheumatoid arthritis may respond in a most startling manner to cortisone. The patient shown in the film was hobbling about with difficulty and evident pain and after seven days of treatment with cortisone he looked and acted well. He was not however badly deformed when his treatment started. Such treatment is, however, not without its disadvantages.

In acute cases such as the boy with the bad eye cortisone or its related compounds may work quickly and the episode

is finished. In the others it is likely that there will be relapses when the drug will have to be used again. Sometimes small doses may be continued for long periods. Nearly always other treatment is combined with it. Spectacular help is received from it in many other conditions but it is not without great drawbacks and, because of possible side-effects and after-effects, it must be used only with great judgment. In the hope of finding some compound which will not have bad effects, much research is being done.

You should not be scared into a dither by a long recital of the dangers of cortisone. Of course it can do harm. It is an incredibly active drug. To allow a poorly trained person to use it is equivalent to letting a child play with a loaded firearm. But remember that doctors are enthusiastic, not only for a lot of good results that they are already getting, but because they feel that at last they may be started on a path to greater things.

## *The pancreas*

Although the pancreas has long been known as a digestive gland, it has also been realized for over sixty years that it is fully as important in controlling the sugar of the body. This part of its work is done by the nearly two million islands of Langerhans that are scattered among the cells of its digestive apparatus. The story of the discovery, by Minkowski and von Mehring, that the pancreas is involved in diabetes is an interesting one. It throws some doubt on the modern belief that if enough money is appropriated the secrets of nature will be solved. These investigators removed the pancreas from a dog to study the effect on its digestion. The dog subsequently died, but with symptoms suggesting diabetes. This hint alone might not have attracted too much attention; but a caretaker noticed that during the life of the dog, whenever it visited a tree stump, flies congregated there. The flies ignored the rounds of the normal dogs. This observation led to the examination of their urine and the discovery that the dog which had been operated upon had urine loaded with sugar. The other dogs on a similar diet had none. I should say that most fundamental discoveries have followed from accidental observations

which have aroused an intelligent curiosity in persons qualified to study the problem.

**Insulin and the treatment of diabetes.** Naturally, from this time on, attempts were made to extract from the pancreas whatever produced this effect on sugar. None succeeded until shortly after the First World War when Banting, a young physician of Toronto, Canada, with his associates, found a way to extract this internal secretion. There have been great improvements since then in purifying and modifying this insulin so that diabetics now may lead normal lives.

There are many interesting and dramatic aspects concerned with this. Dr. Benjamin Harrow, of New York, tells this story.

> I vividly recall a meeting of physiologists and chemists at Yale in 1922 because of an unusual incident. My chief at Columbia (in the department of biochemistry) had asked me to accompany him to New Haven for the occasion. We arrived somewhat late, and though our primary intention was to attend the "biochemical" sections, we inadvertently wandered into a room devoted to "physiology." A young man was in the midst of reading (and expounding) a paper. He was awkward and hesitant, and it was apparent that he had had little lecture experience. From time to time the chairman would prod him. My chief asked his neighbor what the paper was about. The individual in question, a very distinguished physiologist, replied, in substance, "Some paper on blood sugar. About the one hundredth of its kind I've listened to over the years. Pretty bad." The speaker was Banting. The presiding officer was McLeod, professor of physiology at Toronto, under whom Banting had worked. Yes indeed, Banting was actually describing before this audience his pioneer work on the extraction of insulin from the pancreas, and its effect on blood sugar. . . . Within a year Banting had become world famous. During World War II the plane conveying Banting to England crashed and he was killed.

Then there was the rescue of Dr. George Minot, of Boston. He was rapidly succumbing to diabetes when Dr. Joslin learned of Banting's work and got for Minot one of the earliest supplies of insulin. Dr. Minot lived for many years and himself developed the liver treatment of pernicious anemia, until that time a terrible and hopeless disease.

When the cells of the islands of Langerhans cannot produce

enough insulin then diabetes mellitus results. (Mellitus comes from the Latin word for honey, the ordinary source of sweetening in ancient days. We do not bother to use this latter word nowadays.) The body cannot burn up enough sugar and mistakenly calls for more. The liver pours more into the blood and the patient also responds by eating more, especially starches and sugars. Hence sugar begins to accumulate in the blood and soon begins to show in the urine.

As you know, the quickest, easiest way to test for sugar is to examine the urine. This test does well enough for a routine. But some kidneys let sugar through when its concentration in the blood is not very high. Therefore the most accurate method is to examine the blood itself.

Ordinarily the routine of furnishing fuel and burning it goes as smoothly in our bodies as in our households with their oil burners. When excessive demands are made, as for instance in a Marathon race, the sugars are the most quickly changed and used. I understand that fruit sugar is for this reason taken by these long-distance runners during their extended jaunts.

Lowlanders can easily understand that mountain climbing causes a rapid use of body sugar. Long before lunch time the legs feel heavy and the spirits flag. These are symptom of the lowering of the sugar level. A group I know insist on having their "eleven o'clock." Somewhere between ten thirty and noon they stop, take a drink of water and some sweets. One of them, a famous woman mountaineer, always has some high-grade confectionery along. After this they are soon steaming merrily ahead again.

We have derided the Englishman for his habit of supplementing his regular meals with tiffin, tea, and late supper. Nevertheless, his maxim of "dogged does it" has accumulated a good deal for him in the last few centuries. Possibly maintaining a high body sugar by frequent stoking has something to do with it.

One interesting physiological mechanism is the effect of the secretion of the adrenal glands on blood sugar. Under the stimulus of anger or fear, the adrenal pours out secretion which activates the liver to free more sugar into the blood, thereby giving more energy.

I have been told of a diabetic who, knowing he would soon

need more sugar to counteract the insulin he had taken, started home for lunch. He was caught in a traffic jam and soon realized he was getting insulin shock, which is really a lack of blood sugar. Pulling to the curb, he stumbled into a drugstore and asked for candy. The clerk, taking him for a drunk, tried to throw him out. The anger of the doctor freed adrenalin, which freed sugar; his mind cleared temporarily, he explained, he got his sugar candy and went safely on his way.

It is common in considering an example of youthful femininity to say she is a sweet young thing. She or her oldsters may be spoken of as having sweet dispositions. All we intend to imply is that they conform to Webster's sixth and seventh definitions: "not changed from a wholesome state, pleasing, amiable, gentle." But there is a good physiological basis for our description. The healthy person most likely to have these attributes possesses blood as accurately sweetened with genuine sugar as is the most delicate French pastry.

It is well known that the people of the United States eat and drink great quantities of sweets, but even here most of the sugar of the body is formed from starches. Over half the energy of the body is obtained from carbohydrates, and in this country with its sweet tooth, one fifth of the caloric intake (that is, the food that can be burned and hence furnish energy) is accounted for by one sugar, sucrose.

The sugar we use, and especially the starch, have complex chemical formulas. The object of digestion is to change them to simple forms, more easily soluble in water, and more easily absorbed by the body. A little of this digestion is done by the saliva in the mouth, but most of it occurs in the intestine. Much of the simple, soluble sugar is taken into the portal vein. This isn't part of the main blood transportation system of the body, but is a branch line carrying freight from the alimentary canal to the liver.

In the liver the sugar is changed to a special form called glycogen, and is stored there for emergency use. When the body issues a sudden call for more sugar, the liver shifts the glycogen back to its previous condition and ships it out. The liver can, if necessary, change some of the protein of the body into sugar. Thus, in a disease like diabetes where the demand

for sugar is great, much protein may be so transformed. As the bulk of muscle is protein, such a condition long continued may result in emaciation.

This liver function is valuable in the bodily economy, but the liver nevertheless plays here but a minor part. Most of the body sugar is carried directly to the muscles and stored there. As you well know, the mass of muscle in the body is very great, and it performs much mechanical labor. All the sugar in the muscles is used to furnish the required energy, and it is never sent out again into the blood as happens in the liver.

Energy is obtained by the burning of the sugar, just as the energy of your automobile engine results from the burning of the gasoline. In your engine, the necessary oxygen is obtained from the air entering your carburetor intake. In the body the hemoglobin of the red-blood corpuscles carries the oxygen. If combustion is poor in your automobile engine, the result is that much soot forms, gumming up the engine, and little power is generated. I am not sure that the analogy is correct, but I understand that ethyl lead is put into the gasoline to cause better combustion. At any rate, there is some burning of sugar in the muscles whenever hemoglobin furnishes oxygen, but the reaction is poor and inefficient unless insulin is provided.

The insulin that Banting and Best produced began immediately to save the lives of diabetics but it was naturally a crude substance. It was quick acting but not lasting, so that frequent injections through the skin were necessary. It required great vigilance on the part of the physician and intelligent cooperation from the patient. Before many years some ingenious scientists of Scandinavia, where fish fills the consciousness of the inhabitants, combined insulin and fish sperm, thereby obtaining protomine insulin which absorbs slowly and lasts long. Then zinc was added and various modifications have been made since. One injection a day may now often be sufficient.

Few chapters in medicine are more brilliant than the history of insulin. Before Banting's discovery children with diabetes were doomed to an early miserable death. Yet I know a young man, one of the very first to get insulin, who thirty odd years later is a fine specimen, leading a busy good life. He was the type, however, who accepts the discipline of a diabetic life

as character building. The cheaters and eaters of forbidden fruit sooner or later have hard times. Nor does careful co-operation between patient and physician always assure easy success. The islet cells of the pancreas are not the only ones concerned in the handling of sugar. The pituitary, the thyroid, and the adrenals assert themselves with awkward complications at times, and teamwork that has gone wrong makes a mess in the body as on the football field.

## *Sex hormones*

From an historical point of view, a discussion of hormones should really start rather than end with the sex hormones, since some knowledge about the male sex hormone was available in remotest antiquity. It was realized even then that castration before puberty would cause the disappearance of the sexual instinct, so harems in oriental countries were guarded by eunuchs. Domestic animals were also castrated, since capons grew large and fast and oxen grew large and strong. Oxen were also amenable, whereas uncastrated bulls had a bad reputation for sudden ferocity, making them far from ideal beasts of burden.

Not much more knowledge than this was acquired until very recent times when an extract from testicles was found to make capons appear much like real roosters. It was also found that a highly similar extract could be got from the urine. These substances can now be manufactured, and the testicular extract is called testosterone.

Naturally aging men have hopefully wished for the rejuvenating influence of extracts of the testicle. In the last century Brown-Séquard, the great French physiologist, made himself rather ridiculous by taking testicular extract and telling how it had rejuvenated his failing sexual abilities. Undoubtedly there are now on the market many potent "gland extracts." But hormones have a most complicated interrelationship, certainly not clearly understood at the present time, and despite their great value, a large part of their use is still by quacks and irresponsible persons whose optimism far outreaches their judgment.

Female hormones were found some time ago. There is a hormone from the ovary, and another from the cyst of the ovary which forms each month after an ovum has been discharged; and there are others. The chemists have produced in the laboratory synthetic substances with the same characteristics. Stilbestrol is the best known of these, and is a very popular commercial product. Hormones from the pituitary gland have much to do with the regulation of these sex hormones. Just to make the matter more complex and confused, different sex hormones are found in the adrenals; in fact, all the hormones get into this game. And to make confusion worse confounded, each individual has both male and female hormones in his or her system. This is true of animals in general. The stallion, that most virile and masculine of animals, eliminates a large quantity of "female hormone." Professor Benjamin Harrow tells an interesting anecdote of one of his fellow-teachers who mentioned this to his class and received the question, "How do you account for the fact that so much female hormone is eliminated by Stalin?" The womanly streak was evidently detected.

The "antagonistic" properties of male and female hormones are used to good advantage. The male may have a beneficial effect on cancer of the female breast, and the female acts similarly on cancer of the prostate. The first, handled by the late Dr. Ira Nathanson, of Boston, sometimes gave remarkable effects and Dr. Charles Huggins, of Chicago, has shown us helpful results in the second case. Nevertheless, the question of cure is still unanswered.

Capons grow larger than normal cocks, but I doubt that they ever rule a barnyard. We are told that some eunuchs are capable and even wise men. There seems to be good reason to believe that most of the powerful men of the world have been highly sexed. Often leaders of armed forces have been convinced of the association of fighting instincts and sex instinct. Most of the so-called secondary sex characteristics, however, do not seem to run so true to form. Hair on the chest is a "manly" attribute. We have all known powerful, pugnacious fellows who did not have much. And do not presume too much with a man because he has a high tenor voice.

The hormones which are furnished by the so-called sexual

glands are decidedly different in one respect from the other endocrines. When a full-grown man is castrated, or a woman has lost her ovaries, they can, of course, thereafter take no part in reproduction. However, the man may still appear just as masculine as before and the woman as feminine. They may not lose their libido. Life goes on in a normal manner.

How different are the other endocrine glands! If the islands of Langerhans in the pancreas are destroyed, diabetes results, requiring insulin. If the thyroid is removed, myxedema develops, and thyroid extract must be given throughout life. And so with the others. Lose the glandular tissue and a substitute or substitutes must be provided.

The retaining of sexual characteristics after removal of the sex organs may be due to the fact that other endocrine organs, notably the pituitary and the adrenals, also have sexual functions. One thing which must always be borne in mind in considering the hormones is this interrelation. Within recent years our attention has been called to it by the development of ACTH. If the effects of the adrenals are needed, a substitute such as cortisone may be given; or the pituitary may be called upon, in the shape of ACTH, to stir the adrenals to extra activity.

Since the sex glands are all-important for reproduction, they will be discussed further in the chapter on the perpetuation of the race. This, not our individual lives, is nature's prime object. Hence the dominance of the sex instinct. However, as far as the necessity of growing and keeping well goes, the other hormones are more important than those of sex.

### *It's all teamwork*

I think we are justified in looking forward to great advances in the amelioration of human ills by the use of the hormones. Nevertheless, we must realize the multitudinous intricacies of the system which we certainly visualize only dimly at present. In attempting to modify their actions, we may proceed with great hope but with corresponding caution.

Professor Benjamin Harrow has written a clever little book, called *One Family: Vitamins, Enzymes, Hormones*. The vitamins are obtained from outside the body and apparently their

function is to build the enzymes within the body. The enzymes, a few of which have been isolated and collected, are in all the cells of the body, performing a practically infinite number of functions. Finally, the hormones regulate the activities of the enzymes, a job of inconceivable intricacy.

I have heard somewhere the phrase, "solving the riddle of the universe." To my mind a large part of this will be accomplished when we understand the problem of vitamins, enzymes, and hormones.

# 7. Perpetuation of the Race

## REPRODUCTION

SELF-PRESERVATION IS THE FIRST LAW OF NATURE, AND NECESSARILY so, for if that fails there is nothing left. The instinct for reproduction, essential for the preservation of the species, plays it a close second. In fact, the intensity of the second at times puts it in the lead. The carrying out of this instinct in man has resulted in an elaborate set, or rather two sets, of reproductive organs, male and female, and the development of one sexual phenomenon, menstruation, which has resulted in breeding at any season of the year.

The sexual functions of mankind are most closely connected with and influenced by the endocrine system. Both the ovaries and the testes develop hormones and apparently the placenta does the same. These alone do not control affairs, however. Evidently the pituitary leads the whole hormonal teamplay, and the adrenals are spoken of as having sexual hormones. There are two periods of life when striking adjustments take place, and on both occasions the female is more precipitate about the matter. At puberty the girl quickly becomes a

woman, the boy being tardy about his changes. Then for some thirty years or so, the duration varying greatly, the woman is in a potential child-bearing state. When the last ovum is discharged from the ovary, a fairly sudden change takes place and a great rearrangement of the hormones.

## *The development of the reproductive system*

As the reproductive system begins to develop in the embryo, there it little to distinguish male from female. For a few weeks it is impossible to tell an ovary from a testicle. In fact there are not two kinds of organs, just gonads, or sex organs. In a short while, however, the sexes begin to show evidences of manly vigor or gentle femininity. The ovaries stay where they started; on the sides of the pelvis. The testicles move down into the scrotum. We say that they move down, but as the whole body is not so big as hop-o-my-thumb they may stay still while the body grows away from them. At any rate they are anchored by a strand of tissue with the dignified name of gubernaculum. As this word means a rudder, evidently the early anatomists gave them credit for traveling.

Until about the time of birth the testicles are still in the abdominal cavity. With most boys we find them in the scrotum when they are born. But traffic here, as in city streets, not infrequently meets with impediments and sometimes a little patience is necessary on the part of parents. If testicles do not come down, it is advisable to operate well before puberty. With proper loosening of the tissues they may be brought down and secured in the scrotum. It is said that testicles that do not descend are apt to become cancerous. I have never seen such a case but at any rate if they are left inside the abdominal cavity, they do not function. It is nature's design in placing the testicles in the scrotum that they may be kept cool. The thin skin of the scrotum, and its ability to contract or stretch readily, aid in this. The heat of the abdomen stops development. Except for the actual appearance of the sex organs, or genitalia, there is really little difference between little girls and boys.

Until recently, when women have obtained their equal rights, including men's clothes, parents have carefully dis-

tinguished the sex of their offspring by costumes. At the first clinic which our class in medical school attended, Dr. Fred Shattuck showed us a young child and asked if it was a boy or girl. When a student answered, "Girl," Dr. Shattuck asked how he knew this. The answer was, "She has a pink ribbon in her hair."

Puberty, which is the age at which children become adults as far as sex is concerned, usually arrives, in this temperate clime, at somewhere about thirteen years, with boys developing later than girls. But it is not remarkable for breast changes to occur as early as ten, and often complete primary and secondary sex changes may be delayed until well into the teens. Parents must not be perturbed by either extreme.

After puberty, the sex hormones are busy, and many secondary sex characteristics are due to them. Boys and girls before puberty are much alike. Then fat begins to fill in the furrows of the female, giving the pleasing curves; the pelvis broadens and the breasts fill out. Some of the distinctions between the two sexes at this time are due not to changes in the female but to the fact that the male changes and the female does not. In early life the larynx grows in about the same manner in boys and girls. That is why boys can sing soprano. At puberty it increases in size, relatively more in males than females, and especially from front to back. Then the lengthened vocal cords give deeper notes in men than in women. If a boy is castrated well before puberty, the larynx may not enlarge and the voice may remain high pitched. It is said that through the eighteenth century this was sometimes done to keep an exceptional soprano. Terrible things have been done in the name of art. Up to puberty girls and boys both have soft skins and peaches-and-cream complexions. Males in general seem content to take the changes as they come. I have seen no advertisements of male hormone preparations to hasten the appearance of manly beards. Women are different. Commercial enterprise is persuading many young women to use sex hormones. The glorification of the female breast solely because of its pulchritude and aesthetic quality has been seized upon by rather unscrupulous business. Hormonal creams are being urged to keep the skin soft and youthful. Not only are these preparations expensive and of exceedingly little value, but if they ever do suc-

ceed in getting into the system there is a good chance of upsetting a very delicate balance.

How valuable are the sex hormones in treatment? I have talked with gynecologists, genito-urinary specialists, and the head of one of the highest-grade drugstores in the country and have found, as was to be expected with the modern emphasis on sex, and the irresistible power of advertising and publicity, that they are sold in enormous quantities. Possibly less is known accurately about them than about any of the other hormones.

Adolescence, the period of developing maturity just after puberty, is a time of rearrangement of hormones or internal secretions. Although some of the disturbances are physical, the greater proportion are psychic. A rough-and-ready member of our profession, now dead, gave a striking example when he told of a young girl whose parents had been advised by a specialist to give a hormone for her adolescent troubles. He carefully removed the seal from a bottle of pellets and substituted similarly shaped pills of cooking soda. He got a prompt and excellent cure.

Our laws have fixed a definite upper limit of adolescence. Our hormones conform to this law much more often than our mentalities. Gilbert and Sullivan knew of a perfect world where the fairy, Iolanthe, was still seventeen although her half-human son was already five-and-twenty. However, the young lady would not be allowed to vote in either Britain or America for it is the chronological, not mental, age which determines the right to suffrage.

Physically, this is the ideal age of the poets. W. T. Scott thinks fondly of

> The quick limbed, the nimbus-haired—
> Bright along the tide edge.

Longfellow in the age of rhyme saw the girls,

> Standing, with reluctant feet,
> Where the brook and river meet,
> Womanhood and childhood fleet!

Although both male and female reproductive organs are developed at puberty, adolescence, during which the sex hormones mature, is the period before the adult man and woman

are really prepared, psychically as well as physiologically, for that vital function, reproduction.

### *The female organs of reproduction*

The organs of generation, or reproduction, are more quickly spoken of as genitalia and in the woman are also called the pelvic organs since except for their outer opening they are contained in the pelvis. This is the capacious hollow in the bones at the bottom of the abdomen. When it is spoken of as capacious, the woman is referred to. The flaring out, in the region of the female hip and the wide bony arch at the bottom, so widened for all humanity to pass through it, makes a commodious place to shelter the infant until the fourth or fifth month, when his size makes it necessary for him to spread out to the upper abdomen. A broad ligament, running across from one side to the other, slings in its folds the uterus, Fallopian tubes, and ovaries. Some thickenings of this make ligaments which suggest thongs and by tension keep the uterus in the proper position. At least that is their purpose, but not infrequently the uterus, which is supposed to curve forward (we call it anteflexed), takes other positions.

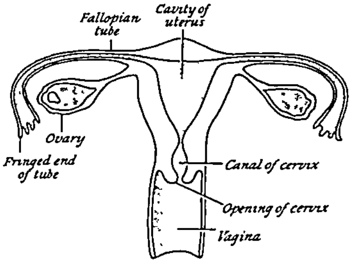
A generation or so ago many of my conscientious, honest, but mistaken friends made comfortable incomes by performing ingenious operations to keep the uteri where they belong. I am pleased to say that able men in the profession itself showed that these operations were not often worth while and they are rarely done now. I know one lovely young matron, daughter-in-law of a gynecologist, who has five children, is busy with many community activities, and yet when she is not pregnant, her uterus is retroverted, that is, tipped back in a manner which years ago would probably have led her father-in-law to suspend it.

The ovaries lie one on each side of the pelvis and contain thousands of cells, each potentially capable of becoming a human being. The average woman, each month sending out into the world at least one of these immature beings, would have to rear a family of some hundreds were it not for the vicissitudes they encounter. The ova are dumped unccre-

moniously into the vast abdominal cavity to find their way into the fimbriated end of the Fallopian tube. Please excuse my not saying "fringed end." Medical literature now extends the world over, so we become accustomed to using words which will be understood by

A Roosian,
A French or Turk or Proosian,
Or perhaps Itali-an.

If, in the tube, the ovum is greeted by one of a reception com-



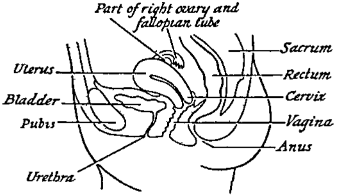

Front view of female organs of reproduction, showing internal structure. (*After S. R. Meaker, A Doctor Talks to Women, p. 7. Simon & Schuster, 1954.*)

mittee of spermatozoa, it may then take up residence on the inner wall of the uterus.

The uterus of a young woman who has not yet been pregnant is an exceedingly firm, muscular organ, about three inches long, two inches broad, and an inch thick. The top is considerably larger than the lower part, called the neck or cervix, which projects a little way into the vagina. Although the uterus is spoken of as having a cavity running through its center and extending at the top to the Fallopian tube openings, actually the front and back walls are normally almost in contact. At the bottom the uterus is pretty firmly fixed to the vagina but the upper part

is movable. The bladder lies in front and touching it and when the bladder fills it pushes the uterus up and back. So when dealing with the uterus at operation or in childbirth it is wise and usually necessary to empty the bladder.

The vagina, which extends upwards above part of the cervix, is also in contact with the bladder here. This is not always too good for the women who have borne babies. Often in later years they find that the tissues lose their elasticity and give way and the bladder bulges down into the vagina. This is called a cystocele. Since the urethra runs down from the




Side view of female organs of reproduction. Cross-section view shows right half of the body. (*After S. R. Meaker,* A Doctor Talks to Women, *p. 11. Simon & Schuster, 1954.*)

bladder in the anterior wall of the vagina, injury to this organ may cause urinary difficulty.

The vagina is about three inches long on the anterior wall and somewhat longer on the posterior one, which is in close juxtaposition to the rectum. At the lower end of the vagina is a membrane, called the hymen, which rarely may close the vagina of a young girl. If it does, it is necessary to cut it before puberty, that the menstrual fluid may escape. The popular impression is that the presence or absence of a hymen is a test of virginity, but on the contrary it may be entirely missing at birth or it may be so elastic as to persist even after childbirth. The hymen, in development, is for protection of the vagina, because this is easily irritated in the immature female. Usually it is broken at the first intercourse, and slight bleeding results.

The vulva, at the outer opening, consists of the labia majora, or outer lips; and the labia minora, or inner lips. Between them anteriorly is the clitoris, usually a minute prominence but which in a so-called hermaphrodite may be so enlarged that it suggests a penis. It seems to have no function except as the seat of sensation.

Every married woman, at least, should expect a vaginal examination. A tremendous lot of information may be got from it. Scores of possibilities are surveyed, but what we are concerned with now is only the reproductive system. The normal ovaries are small, soft affairs, which feel like oysters under a blanket. Contrariwise, the uterus is definite and easily examined, just against the anterior abdominal wall.

With two fingers in the vagina and the other hand on the abdominal wall the uterus should be picked up by what we call bimanual examination. The experienced examiner can pretty well judge just what he is feeling between these two hands. Having found what is normal we may recognize the abnormal, such as enlarged ovaries or uterus and tumors where they do not belong. We must remember, however, that the wise examiner may use considerable latitude in judging what is normal. In the past, too many ovaries were removed because they were larger than the textbook dimensions. A vaginal examination, if carefully done, should be painless, so tender areas may mean there is something wrong. But be sure you differentiate between nervousness and painfulness.

Examination by feel is not enough. Direct vision must be used. This is aided by a speculum. This instrument is made in numerous designs, all intended to open the vagina so that the physician may see clear to the cervix, or neck of the womb. Abnormal conditions may be recognized or, to take a more optimistic attitude, we may reassure ourselves that they are not present. Nowadays the careful physician supplements the vaginal examination with a rectal one, which just on general principles is a valuable part of a physical examination.

**Menstruation and conception.** So much for the anatomy of the female reproductive organs, described as they are found throughout the major portion of adult life. You know, however, that there is no part of the body where anatomy is routinely changed more by physiology than in the reproductive organs.

The chief anatomical changes are: the monthly formation of a cyst where the ovum has been pushed out from the ovary, a sloughing off of the inner lining of the uterus, and in many cases some congestion of the breasts.

These phenomena of menstruation occur usually every four weeks. The changes in the lining of the uterus prepare it for the reception of the impregnated ovum. The uterine glands enlarge and there is an accumulation of fluid in the mucous membrane, which is much thickened. If there is no pregnancy, then the lining breaks down and sloughs off, with the resulting menstrual bleeding. The raw surface heals in a few days and normally remains so until the next menstrual cycle. Once this cycle is well established, it goes on, in the great majority of cases, regularly; so regularly, although the number of days varies somewhat for different individuals, that a popular name for it is the "monthlies."

A generation or more ago, girls were told that during menstruation it was dangerous to wet their feet or to take any exercise beyond the mildest, and bathing was absolutely taboo. Now they are advised to continue their normal physical activities and sports, including swimming. Baths are not only allowed, they are encouraged as proper hygiene.

Some time, about at the end of menstruation, a little sac of fluid begins to form in an ovary. On the wall of the sac is an ovum. About two weeks before the next period (this may vary) the sac ruptures and the ovum is, for a short time, free in the abdominal cavity. This is known as ovulation. It is usually symptomless, although apparently not always so, as the Germans have a term, *Mittelschmerz*, for the discomfort some women feel at this time.

It is believed that during only a short period, at the time of ovulation, can a woman conceive. The most common method to determine when a woman ovulates is to keep her daily *temperature record*. About the middle of her period between menstruations she shifts from a lower to a higher level of temperature. This means ovulation and, for a period of about 24 hours, the possibility of conception.

In the hollow space left when the cyst ruptures, yellow cells appear, forming what is known as a corpus luteum, or yellow

body. This produces a hormone which keeps the lining of the uterus in good condition for the embryo nestled there. If no pregnancy has occurred the corpus luteum quickly realizes the futility of its work and dries up in a fortnight or so. Without the stimulus of two hormones secreted by the pituitary and acting on the ovaries women would not menstruate or conceive.

The ovum which has not been fertilized is an insignificant, microscopical piece of material that is easily disposed of and plays no further part. If the ovum is fertilized by a sperm, it then settles itself in the lining of the uterus which has been prepared for it, and the resulting changes of menstruation do not occur.

The sex hormones, having done their work, are eliminated through the kidneys. Two clever investigators, S. Ascheim and B. Zondek, took advantage of this disposal to perfect a test for pregnancy. Soon after a menstrual period has been missed, leading to a suspicion of pregnancy, the woman's urine is collected. Originally some of this was injected into a rabbit. Later, inexpensive, immature mice were used. After a few days the mouse was killed and changes in the ovaries, if present, settled the question. Now the serum of the mother's blood is sometimes used, instead of urine. Also, male frogs are substituted for mice, and the effect on the testicles is noted. Presumably several more developments will occur before this book gets into print. But the primary phenomena of all these tests will remain the same.

**The Caesarean section.** After the ovum has been implanted in the lining of the uterus, this does not merely stretch to make room for the growing child. It also grows, becoming a heavy muscular organ. At the fourth or fifth month it has grown as high as the umbilicus, and at full term reaches to the top of the abdomen. When labor starts, the powerful and decidedly unpleasant contractions demonstrate the presence of plenty of musculature. I said that the uterus grew large but did not stretch. That is so until labor begins and then this versatile muscle adjusts itself most remarkably. While the upper part remains heavy and strong, the lower part does begin to stretch until finally there is an opening large enough to let the baby's head through. And then when the baby leaves, the great mus-

Thomas Eakins, *The Gross Clinic.* An operation without anesthetic, under the supervision of the famous nineteenth-century surgeon of Philadelphia. Asepsis, or cleanliness, meant nothing to the early operators. They would not even have worn their dirty suits in ordinary life. *(Metropolitan Museum of Art)*

cle contracts down until, having pushed the placenta or afterbirth out, it is small enough to nestle well down in the pelvis. Truly an ingeniously adaptable musculature.

Shakespeare tells us that Brutus gave Ceasar the most unkindest cut of all; one of my fellow-surgeons way back in those days did just the opposite, for it is said that Caesar was born by way of a cut through his mother's abdominal wall and into her uterus. Such deliveries have become common now, and, until the last quarter century or so, had not changed greatly since the old Roman days. It must have been rare for a woman

An operation for a fractured hip in a modern hospital.

to survive this operation before the days of anesthesia and asepsis. Even with those aids, one took an added risk in doing a Caesarean. There was considerable blood loss and danger of peritonitis if the woman had been subjected to previous examinations. Today surgeons proudly do an operation which does not open the adbominal cavity at all. I am able to give you a good description of this operation from a source one hundred and twenty-five years old. Dr. William Potts Dewees

wrote a famous *System of Midwifery* and in it was a letter from one Dr. Horner, regarding the Caesarean section. I quote:

> Dr. Physick proposes that in the Caesarean operation a horizontal section be made of the parietes of the abdomen just above the pubes. That the peritoneum be stripped from the upper fundus of the bladder by dissecting through the connecting cellular substance which will bring the operation to that portion of the cervix uteri where the peritoneum goes to the bladder.

As some of these words may be unfamiliar to you, I will elucidate. The operation consists in cutting across the lowest part of the abdominal wall. The lining of the abdominal cavity reaches as low as that. As it is loosely attached to the bladder it may be dissected free and pushed up. Hence without opening the cavity the surgeon may reach the lower part of the uterus. This is cut open, the baby and afterbirth extracted, and all the layers sewn back in place. When Dr. Physick suggested this, there was no anesthesia or asepsis. Patients just could not stand such long careful dissections. About a quarter century later the use of ether for anesthesia was begun, and before the end of the century asepsis was developed. It was a good many years more, however, before this operation so well described by Dr. Physick was adopted. This was presumably due to the modern contempt for historical perspective. The late Dr. Samuel C. Harvey, professor of surgery at Yale, told me that it was a rare student who felt there was anything worth knowing that was over ten years old. Probably some proud surgeon invented this operation a century after Dr. Physick had described it. It might well have been used many years before.

### *The male organs of reproduction*

The most important male reproductive organs are the testicles. They have two functions. They furnish spermatozoa and they produce the male sex hormone which gives the secondary sex characteristics: the beard, the male voice, and others which distinguish man from woman. Castration before puberty stops both these with a resulting ox instead of a bull, and a eunuch instead of a well-developed man; when castration is effected in

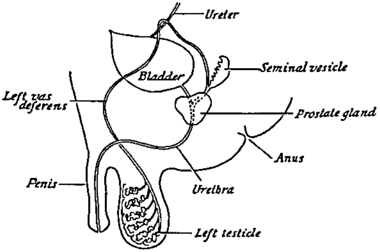
later life only the first function, the production of the spermatozoa, may be lost. The main body of the testicle furnishes these and they are stored in the epididymis, which lies along the posterior surface and is the beginning of the vas deferens, a tube leading up to the prostate gland.

The naturally great respect which men have always accorded to the testicles is shown in their very name. It comes from the same source as testament and testify. In the days before the Gutenberg Bible, our frank, straightforward ancestors, having no holy book on which to take an oath, had the man, when swearing, place his hands over what were therefore called the testes.

While a woman produces, ordinarily, only one mature egg a month, a man is constantly manufacturing spermatozoa in enormous numbers. Nature is lavish, both in the vegetable and animal kingdoms, in planning for the preservation of the species. When a normally fertile man has intercourse, spermatozoa numbering several hundred million are deposited in the vagina. The great majority of these are killed by the vaginal moisture, but many of them, propelled by their long tails, arrive inside the cervix and continue their journey upwards. They swim with considerable speed and some are able to reach their destination, in the outer part of the Fallopian tube, in possibly half an hour or so. When one of these spermatozoa meets a fresh ovum (ova lose their vitality in about twenty-four hours) and penetrates through the outer clear zone of the egg, fertilization has occurred. Almost immediately the cell wall of the ovum undergoes a change which makes it impossible for other sperm cells to penetrate it.

The testicles and their function have been described entirely out of relation to the urinary tract, but the same cannot be done for the rest of the male genital system. The vas deferens, reaching from the testes to the prostate, hooks itself closely around the ureter and finally finds itself discharging into the urethra as the latter passes from the bladder, through the prostate, and along the length of the penis. Here the two systems may be as distinct as the New Haven and the Pennsylvania Railroads but they use the same right of way, as do the trains from New York to Boston.

The prostate, so named because it stands before the urinary bladder, is a sex organ. In association with the seminal vesicles, one on each side, it forms a fluid which carries the spermatozoa. Apparently its only relation with or effect upon the urinary system is to interfere, when it is abnormal, with the free flow of urine. The changes in the prostate, which so frequently lead to its removal, fortunately occur in most instances late in life, when the sexual function is not so important. There may be enormous increase in size, but a small increase just at the opening from the bladder may be bothersome out of all proportion. There is still no accurate knowledge as to why these changes




Male organs of reproduction, side view.

occur but a natural surmise is that they have to do with the changes in endocrine function so common in advancing age. There is no evidence, however, that we can influence the changes by hormone treatments. But genito-urinary surgeons are at the top of their game on this, their home field. Life before the removal of the prostate may be most miserable. The transformation afterwards is usually delightful.

## Menopause and climacteric

The end of the child-bearing period is the menopause. This is the second time in a woman's life when the workings of the sex organs are greatly modified and produce disturbing symp-

toms. The first time is at puberty. I imagine that most girls are elated to feel that they are really becoming women and no longer need to dress in their mothers' old dresses and play "grown up." Hence they bear with equanimity some unpleasant aspects.

Difficulties with menstruation, the unpleasant symptoms of the menopause, and a few other situations may call for the use of sex hormones, but the frequency of their use is generally in inverse proportion to the knowledge of the physician who is prescribing them. The psychic effect is particularly difficult to separate in these cases, but we may remember that over several generations, when these hormones were not in use, a large fortune was made and maintained by dispensing only vegetable compounds for female troubles. The vegetables were inert physiologically and safer than the powerful hormones.

Women at their menopause, the "change of life," do have an upsetting of their endocrine balance. In fact they have some upsetting at every menstrual period. Some have a great deal of disturbance every month, leading them to refer to the "curse." But, at the time when these periods are ceasing and the whole hormonal system is readjusting, a woman is likely to have a lot of other things bother her, too. The menopause notifies her that she is losing her youthful charm – she is on the verge of becoming elderly. Naturally the psychic effect is bad. She is, in some cases, unnecessarily upset by the belief that she will soon lose her sexual attractiveness to her husband. This is not the case. She ceases to have a menstrual flow and to ovulate, but her other sexual functions and desires are unimpaired.

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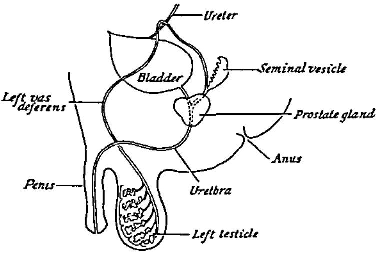


Male organs of reproduction, side view.

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Along with the change of life other physical causes of discomfort become more common. X-rays demonstrate that practically everybody is then developing some arthritis, and arthritis often is uncomfortable. Pseudo-medical literature in modern abundance, and advertising, keep up the suggestion that the woman in the late forties is in for trouble. What woman has not seen, in the advertising pages, photographs of her unhappy sisters who, she is told, look thus because of the change of life? It is a tribute to the female sex that, as far as a mere man is able to notice, most of them are able to show little change in their equanimity at this time.

The menopause is complete when the ovaries have ceased to perform their normal function. There are rare occasions when a woman may menstruate regularly for years and then abruptly cease for the rest of her life. Usually it is a gradual change, in reverse, to that which occurs at puberty. Most young girls do not immediately start into a normal menstrual cycle. They are irregular at first and it is well known that they are apt to have irritable, nervous symptoms as well as physical difficulties at that time. At the menopause the same irregularity and symptoms are the rule. The age at which it may occur is variable. Not too uncommonly it appears at about thirty-five, and two of my gynecological friends have told me that they thought the average age is over fifty. It frequently is difficult to say with certainty when the menopause is fully completed. If I may use an arbitrary figure, I should therefore say that any woman who has ceased to menstruate for six months and then appears to start up again, should have a careful physical examination, as there are numerous bad conditions which may simulate menstruation.

The menopause is frequently accompanied, we don't quite understand why, by sudden slight disturbances of the circulation, called vasomotor symptoms. A wave of heat passes over the entire body, and is often followed by a profuse sweating. There may occasionally be a sense of violent heart-beating, almost a feeling of suffocation. These symptoms may be disconcerting but they have no special importance. One cannot be too exact about how long they will continue.

A woman told me that she had been having "hot flashes" for fifteen years. The modern use of hormones at the time of the menopause may prolong the period of symptoms. Since the ovary is one of the many glands of internal secretion which work together in sexual matters, when it stops functioning, the whole system is put out of balance and adjustments have to be made. The adjustments may not take place if ovarian extracts are supplied. Undoubtedly the judicious use of hormonal therapy may at times be well worth while. The great trouble is that it is frequently overdone and over prolonged.

There is much talk made about the male climacteric, this word corresponding to menopause. I do not believe that there is any such real phenomenon. From somewhere in the twenties

a man naturally slows up in all his functions and physical activities. But there is no sudden and complete change in any function as in the case of women. There is some good evidence that sexually some men change very little. William Harvey, who demonstrated the circulation of the blood, made an examination of Thomas Parr when he died at the reputed age of over one hundred and fifty-two. "It seemed not improbable that the common report was true, viz. that he did public penance under a conviction for incontinence, after he had passed his hundredth year." Birth and death returns were not carefully kept in those days and Thomas Parr was probably just an unusual example of a common situation.

## *Sex and marriage*

Reproduction can occur, of course, any time during the thirty-odd years or so when a woman is having her menstrual cycles. The age at which young couples have usually started their marital adventures and produced their progeny has varied during the centuries and according to their social environment. Until fairly recently, the numerical difference between the number of children conceived and the number who grew up has been tremendous — a sad part of family life.

Not too many generations ago, a woman unmarried at twenty-one or twenty-two was probably a spinster for life and a man over twenty-five a confirmed bachelor. Then came a period when the American man, in order to be self-respecting, had to be able to support his wife in her accustomed standard of living before he applied to her father for permission to become her recognized suitor.

I have a book written in 1875 to tell the facts of life, and the author says: "A man, having arrived at the age of thirty years, full grown, perfectly developed and desirous of marrying, should choose a woman who is not below twenty-four years of age." Dr. Charles W. Eliot, a much wiser man, said that the one advantage the poor had over the rich was that they contracted earlier marriages. I am pleased that recently the general trend seems to be towards earlier marriages and larger families.

There have been numerous books of sex instruction for newly

married couples. In Victorian days they were so "respectable" that they would not bring a blush to the cheek of a Jane Austen heroine. Some of the recent ones would startle the most sophisticated clubman and tell him things he knew not of.

We now have our hero and heroine safely married. But are they going to live happily forever afterwards, as the story books have told us? The modern stories of true love, unhappily, too often have different endings. Platonic love was long ago admitted to be negligible in the mating of man and woman. We were careful how we discussed sex as the foundation of romance, but nobody disputed the part it played. Today we are realizing that too often it makes and breaks the bonds of matrimony. How shall we reduce these latter unfortunate accidents?

The old ascetic idea, that sex relations are for propagation purposes only, has of course been given lip service only, and now it is certainly not given even that. It is frankly admitted that the associated pleasure results in the strongest of human drives, next to self-preservation. It is the most intense expression of physical love between husband and wife.

But students of this situation are convinced that maladjustment of sex relations is the greatest cause of the break-up of family life that is such a blot on modern society. Divorce court judges and others in a position to know tell us that sexual maladjustment plays a part in almost every divorce. Both man and wife should have equal desire for intercourse and should get equal satisfaction. Apparently the average woman is sexually aroused more slowly than a man and requires more time to reach a climax. Hence, when the husband's orgasm occurs and she has none, she may be left with her organs congested and with keyed-up, unsatisfied emotions.

The chief remedy for this, in most cases, if not all, is a period of preparation with much love play. Some modern books go into detail about the technique of this. It would seem fair to believe that not all of it needs to be carried out by every couple, but the modern young girl approaching marriage should understand, and probably does, that "dignified acquiescence" alone is not apt to be enough for a perfect marriage.

Pre-marital consultations are common now. The ideal consultant would seem to be a physician, but he needs much more

than medical knowledge. "Psychology" must be a part of his equipment, but always with the understanding that psychology is no more an exact science than is medicine.

As regards reproduction, women, with today's medical and hospital standards, can be happy and safe both before and during childbirth. When they are pregnant, they often have an added attractiveness – a sort of glow. If expectant mothers want advice, they had much better listen to their doctors, not to their friends.

There has been speculation as to whether the children born of young parents are inclined to be healthier than those with older parents; and whether the babies with more mature mothers and fathers are more intellectual. The amazing variations in the offspring of the same parents and with the same environment lead to our consideration of the remarkable fact that the tiny ovum, fertilized by the tinier sperm, can contain many potential characteristics. These characteristics are, of course, as the sands of the sea and yet they are undoubtedly not subject to chance but are governed by rules, as are all the forces of the universe. Our slowly accumulating knowledge of this is the subject of the modern study of heredity.

## HEREDITY

So far you have had a discussion of the modus operandi for reproducing the human race. It does not differ greatly from that of a number of the larger mammals except that, I believe, none of these has such wide choice of time when they can conceive. Students of the subject tell us that human conception occurs more often than is generally realized; that many pregnancies terminate so early that the parents are totally unaware of what has taken place. These learned men also inform us that in much the larger proportion of interrupted pregnancies, males are found. Evidently for some obscure reason males are at all stages the weaker sex and nature compensates by seeing that many more males are conceived.

There is one other little matter that I trust somewhere along the line has been called to the attention of Henry VIII and the other toughs who have treated their wives rough because

of lack of male heirs. The determination of sex occurs in the male parent. Before attempting to explain to you why some of us inherit the male sex and some the female, it will be necessary to give a short statement as to the mechanics of heredity.

Charles Darwin, in his *Origin of Species,* based his conclusions on a tremendous number of observations on animals and plants with relation to the characteristics they had inherited. Meanwhile an Austrian monk named Mendel worked in a narrower field but more intensively, studying the common pea, *pisum sativum.* Likewise the cell theory was evolved in those days. Each living body consists of cells and these all arise from one germ cell; in the human this cell is the mother's ovum, fertilized by the father's sperm. In the cell are a number of "chromosomes" which contain all the characteristics of that particular body. The hereditary factors, in the chromosomes, are called genes. Both parents contribute genes. In the offspring of two Negroes all the genes relative to color are the same and the child will be a Negro. If a white and a black breed, the child will have characteristics of both parents. In further breeding both types of genes are present and there is the possibility of further diversity.

Let us return now to the determination of sex. With regard to the sex factor, the female produces only one kind of egg, each containing X factors, but the male produces two kinds of sperm, one half X bearing, the other half Y. When the ovum and sperm unite, if the male furnishes an X, then an XX child results, which is a girl. If a Y gets there, then XY, or male, results. The mother has no part in determining this combination.

As far back as man has kept records he has been interested in heredity, which has to do with the transmission of physical and psychical characteristics to offspring. The details of this are tremendously complex and much misunderstood and debatable, so in any discussion of it the question is not what to include but what to omit. Until the last century there was little accurate knowledge of the subject, records having to do with pedigree being notoriously fallible, because, as Shakespeare said, it is a wise father who knows his own child.

There have been many misconceptions about human heredity; most naturally, for humans are impossible to control

accurately, and to be of value observations have to be made over a number of generations. But the laws of heredity work in all animals and by studying short-lived ones, easily handled, much may be learned. The extreme example is the study of fruit flies. A pair of these have two or three hundred children at a time and there are forty generations in a year. Figuring with the smallest figure, you find that theoretically the prolific pair might have a posterity of over twenty billion in a month and a half. Two thoughts inevitably come to mind: what a wonderful opportunity to study inheritance, and how fortunate that there are so many lethal agents in the world.

It is granted that the laws of heredity do hold for man, which is what we want to know, for what cares the average person as to the scientist's experiments with guinea pigs, flies, or plants? We cannot keep family records as we do with fruit flies for, although Joseph Smith's family may have lived in Vermont for a century or so, his posterity lived in Utah and the early Mormons practiced polygamy, complicating statistics. The royal families of Europe, however, practically lived in showcases, and their famous disease, hemophilia, in which some of the men were "bleeders," could be shown to be hereditary, although tracing this was tricky. As only the men have the trouble and only the women transmit it, a couple of generations without sons could put the matter beyond the ken of many families.

I had no uncle or great-uncle on my mother's side, so there might well have been a bleeder in my family about the time of the Revolution without my knowing it. The fact that I am not a bleeder proves nothing, for only a small proportion of possible inheritors get into trouble. In fact, I have just seen in a good book on heredity the pedigree of a bleeder family, and out of twenty-two men in three generations only three were bleeders. Perhaps this will convince you that heredity is a mighty intricate subject.

### *The case of Charles Darwin*

I am forever being asked if first cousins should marry, for a large portion of the public are pretty well convinced that such marriages bring bad results. This notion is due to the great

publicity given to a couple of families whose members intermarried for generations and produced a sweet crop of degenerates and jailbirds. But these people bred for bad traits as consistently as the owner of a stud farm breeds for desirable traits. And think of the environment in which they lived! On the other hand, consider the Darwin family. There were a series of cousinly marriages between the Darwins and the Wedgwoods, two remarkably gifted groups. The outstanding result was Charles Darwin, one of our greatest geniuses and he had a group of brilliant descendants. Never was there a greater student of heredity and environment. His decision was, "Education and environment produce only a small effect on the mind of anyone, and most of our qualities are innate."

In the days when Samuel Johnson was closely connected with his birthplace, Lichfield, the leading physician there was Erasmus Darwin. For at least three centuries his ancestors had been important people and well-to-do. Besides being a successful practitioner he was a poet and a botanist whose fame still lingers. Johnson's abilities died with him. On the other hand Erasmus Darwin's great qualities undoubtedly were bequeathed by him to his posterity. He had four children by his first wife, six by his second, and two illegitimate in between. His son Robert was also remarkably successful financially as a physician.

Contemporary with Erasmus Darwin, Josiah Wedgwood established and made famous his great pottery. He married his cousin. They had a son, and also a daughter who married Dr. Robert Darwin. A child of this union was Charles Darwin, a naturalist of unsurpassed renown. Charles married his cousin, daughter of his mother's brother. If you can follow this you will see that Charles Darwin had two remarkable men as grandfathers and in three generations there were two marriages of first cousins. As human affairs go this was pretty close in-breeding of very able stock.

Charles Darwin and his wife, Emma Wedgwood, had ten children. The last child, who unfortunately was chosen to be named after his father, was a mental defective and fortunately died at the age of two. There was a popular impression which still seems to be not completely abandoned that marriages between cousins are likely to have such results. A rare occurrence such as this may help to confirm the belief. But this was

one child in ten. Two other children died young. The others were remarkable. Four of the boys became distinguished, three of them being knighted for scientific achievement.

Now in attempting to improve domestic animals it is perfectly well understood that discrimination must be used in breeding. Undoubtedly tremendous stud fees were paid for the services of Man o' War. I do not know the record of his progeny, but I wonder if their fleetness of limb was any more consistently good than the intellectual results achieved through the careful selection in the Darwin and Wedgwood families.

But, as a mayor's wife is said to have remarked to a visiting queen, "Breeding isn't everything." Environment is of great importance in the upbringing of blooded horses or brilliant children. *The second problem is the more difficult. The trainer* of race horses can be arbitrary and it is safe to say that he is rarely swayed by sentiment. Neither do his charges have such complex psychology as do intellectual human beings.

Environment refers to the conditions which surround and influence one during life. Kipling tells of a boy taken by wolves in infancy and brought up by them. It is reasonable to suppose that the result was different from what would have occurred had the youngster grown up in a comfortably fixed, well-educated family. The Darwins, although no Rockefellers, certainly had their share of the good things that an adequate income brings. Dr. Douglas V. Hubble, in the *Lancet*, told how they developed under these conditions.

Charles Darwin's father had plenty of money to spend on his family, but although not cruel, he ruled over them with *a rod of iron, always as he supposed, for their own good.* Naturally, he did not develop in the children a feeling of confidence in themselves. Then they had it dinned into them that the hazards of ill health can be eliminated by the exercise of precautions. *"Always wear rubbers and mufflers and avoid* drafts and you will grow up strong and well." This tradition came down so that the *Lancet* article is called "The Life of the Shawl." One son always wore a shawl except on the rare occasions when he felt that all conditions including health were perfect. Henrietta always wore one. She was recommended, when twelve years old, to have breakfast in bed. She did so until she died at eighty-six.

So Charles Darwin early in life naturally became a hypochondriac. (The hypochondrium is the upper part of the belly just below the ribs and was thought to be the seat of melancholy.) In his early twenties he was on the brig *Beagle* ready for a voyage as a naturalist around the world. "I had palpitations of the heart. I was convinced that I had heart disease. I did not consult any doctor as I fully expected to hear the verdict that I was not fit for the voyage and I was resolved to go at all hazards." So he took his six-year trip to Patagonia and the slopes of the Andes and the Galapagos Islands and many other outlandish places. You should all read the *Voyage of the Beagle.*

Robert Louis Stevenson, riddled with tuberculosis, and Charles Darwin, just as sick with hypochondria, both traveled to the far parts of the earth and each did a wonderful lifework. Stevenson apparently died of a brain hemorrhage; and Darwin, who lived to old age, certainly did not die of hypochondria. So in Darwin's case "intellectual endowment ultimately triumphed over harmful environment," and with Stevenson it triumphed over tuberculosis.

Darwin married soon after he returned from the *Beagle* trip, and then his hypochondria really did become pronounced. It is said that he was the perfect patient and his wife the perfect nurse. She watched over him day and night and regulated the whole household so as not to disturb him. He looked to be and evidently was in robust physical health but he would "lie awake at night in an agony of mind and intestine." Yet our author believes that "illness provided the exact conditions essential to his achievement. Sleepless nights allowed him to brood over his problems: two hours in the morning to look things over and make his records" seemed to be his day's work.

Charles Darwin and his wife did their best to bring their children up in a loving manner with lots of material advantages. They were not so autocratic as the grandfather had been, but the mother saw to it that the children did not interfere with their father's work and his "sickness." He himself was so kind and considerate that they were glad to do this. The result was a group of remarkably brilliant children, but Darwin's granddaughter who lived with all of them shows in her book that they were decidedly "queer."

What can we make of this family history? It demonstrates once again that qualities of intellect can be built up and transmitted in human beings just as large milk production in Guernsey cattle or beautiful blooms in Brownell roses are achieved. The Adams family in this country does the same. The problem is not so easily solved in humans, however. Blooded bulls are kept in pens. When a virile man sees a handsome woman he is not so easily kept from roaming, ignoring the development of intellects. And once again we see that too much of a good thing is a bad thing. There was too much care and protection in the Darwin family.

Environment produces superficial appearances that make it difficult at times to recognize the inherited characteristics. The Negroes in my neighborhood now have hair which is straight or slightly wavy. But somebody has made a fortune selling a preparation which takes out the curl. Stephen Foster spoke of the top of the head of his bald Old Black Joe as the place where the wool ought to grow. Some sour-dispositioned caustic person, speaking of girls who have their teeth adjusted at great expense to make them beautiful, remarked that they may get husbands and raise generations of buck-toothed children.

Kinky hair, arrangement of teeth, numbers of fingers and toes (some families are apt to have more than five on a hand or foot), color of hair and skin, shape of eyeball causing nearsightedness, all these and many others can be traced to heredity. People who admit these physical attributes are hereditary are often more skeptical about mental endowments. They point to Abraham Lincoln, who himself could certainly not show a distinguished ancestry. A friend of mine, exceedingly well versed in Lincolniana, told me that the ancestry could be traced back to the New England Lincolns, many of them able. On the female side, it is generally believed that Nancy Hanks was illegitimate and Lincoln himself thought her father a well-to-do Southern planter. There is a story, probably apocryphal, that John C. Calhoun was involved. At any rate there was good chance for the presence of an able progenitor here.

However, J. Walter Wilson, a distinguished scientist in biological branches, tells me that everybody of English ancestry undoubtedly has a pedigree going back to William the Conqueror, so I suppose that Darwin and Lincoln may have

had their genius come down from William the Bastard, as he was sometimes called, without its stopping on the way long enough to receive recognition. Perhaps many desirable qualities had developed in various ancestors — intelligence in one, courage in another, honesty in a third — and when by chance, as it were, they all culminated in one man, then we had Lincoln.

### Heredity and disease

Probably most of you are not looking forward to geniuses in your families; the records show us that they may be decidedly undesirable. But you do wish to know if any hereditary diseases will attack them. Probably all of you know that mice are bred so that certain strains may develop cancer in nearly all the offspring. In human beings, study of identical twins (that is, twins developing from the same egg) show evidence of the inheritance of disease, for example, cancer. No less a person than Dr. Eliot P. Joslin, of Boston, told me that heredity plays a part in diabetes. I, in my ignorance had said the opposite.

So there is conclusive proof that heredity is a factor in disease. Sometimes the disease itself is inherited; in other cases conditions are inherited which prepare the ground for the occurrence of disease. It used to be said that persons inherited tuberculosis. We know now that is not so, although apparently a constitutional susceptibility to it may be. In fact, infectious diseases, when they occur, are part of our environment.

The disease formerly the most dreaded of all, smallpox, is practically non-existent in the United States. Why was it, then, that seven years ago when a man traveled from Mexico to New York City and was then found to have died of smallpox, the health authorities there went berserk, vaccinating most of New York's population?

To understand this panic it is necessary to know some history, since hardly any of us has ever seen a case of smallpox. In 396 B.C. a terrific epidemic of smallpox so ruined the Carthaginian army that they were unable to cope with Rome, else the entire history of the world might have been changed. This was only one of many wars whose outcome was decided by smallpox.

It nearly did for the American army in the Revolution.

General Sullivan wrote to Washington, "The raging of the smallpox deprives us of whole regiments in a few days." The treatment was servings of rum, with four pounds of gentian root and two pounds of orange peel to a hogshead. The men liked the flavoring and were happier for the rum and today we could do no better by them as the only cure still is to avoid it. Some of the army physicians tried to prevent the infection by inoculating the men. This method had been introduced into England early in the eighteenth century by Lady Mary Wortley Montague, who learned of it during her travels in Turkey. She described how they took smallpox matter from mild cases and put as much as could lie on the needle into a vein. "There is no example of anyone who has died of it."

You see everybody took it for granted that sooner or later they would catch the smallpox so they preferred to get it from mild cases. Unfortunately it occasionally shifted from its mild nature and killed the person inoculated. It did not choose its victims from any particular rank in life. Royalty contracted it as well as the humblest peasant. Princesses had their beauty ruined, for when it did not kill it often left its victims disfigured for life.

For centuries plenty of Europeans had smallpox but those who survived acquired immunity. Mothers transmitted some of this to their offspring; many attacks were probably so mild that they produced little effect except to build up an inherited immunity.

It has been the experience throughout history that populations not accustomed to smallpox are extremely susceptible. When Cortez landed in Mexico with a few hundred men, one of them had smallpox. Three million Indians died as a result, and Cortez earned the reputation of being one of the great military geniuses of all time. The one who really deserves the esteem was the man in his forces who landed with smallpox. The natives had absolutely no immunity and died like mosquitoes sprayed with DDT. But moderns pride themselves on ignoring history; they have not seen smallpox or its disfigured survivors and they are careless. So vaccination in the United States is undoubtedly being slighted except by those who are going out of the country. (They know that they cannot get back

without a certificate of vaccination.) If virulent smallpox should appear in our environment from some obscure corner of the world, it might find a community with little immunity, inherited or acquired, and a severe epidemic might then ensue.

## *The effect of environment on heredity*

When we come to consider the general relationship between heredity and environment, not as regards disease, but as regards characteristics, we find there has been a great controversy in the past. Can acquired characteristics be inherited? Biologists of the present day are pretty well convinced that they cannot. Here is a big experiment. Jews since many centuries before Christ have been circumcised. And yet after all these centuries the prepuce of a Jewish baby is just like that of a Christian.

But I think that one can see how environment might affect heredity in some characteristics. Darwin in his *Origin of Species* advanced the argument of the survival of the fittest. If a certain characteristic might benefit the animals possessing it, then those having it to a superior degree have a better chance to survive and pass it on to their offspring. Certainly the environment might determine what are the best characteristics for survival.

If, as Dr. Wilson told us a few pages back, all people of English extraction have a pedigree going back to William the Conqueror, presumably we are all related. Why do we not then, have the same inheritance? In the nearly ten centuries since the Conqueror, his many genes have occurred in his descendants in a tremendous number of combinations. I think there is an analogy here with the brown trout of the fish hatchery at New Hampton, New Hampshire. In one pool there are many big white trout raised from fingerlings in the regular pools. We are told that about once in every seven million there is a white one. If he is scooped up and put to one side he grows into a big white fish. But bred to a brown one we are right back where we started. One seven-millionth of a chance of our being a genius just because we are proud of our pedigree from William the Bastard?

John Buchan wrote a book called *The Path of the King*, which is an allegory concerning great inheritance. In the woods and fens of England, long before the Normans conquered at Hastings, a witch gave a young boy a gold ring. Always the possessor would have strength, ability, nobility in the best sense, and perseverance to carry through his good intentions. Through the centuries a series of owners of the ring displayed all the great qualities the witch had promised, but they always perished while carrying out their endeavor. In the final episode Nancy Hanks Lincoln passed the ring to her son Abraham who lost it, but as the mother saw in a deathbed vision, only after he had inherited the gifts of the ring in quantities far greater than ever before. We know of but few possessing the ring throughout its long history, nor do we know the paths by which it came to Lincoln. The accurate tracing of human heredity is an all but impossible task. The possession of great qualities is not necessarily made known to the world for they may well lack the opportunity to be demonstrated. Circumstance plays a large part in man's existence. The poet Gray reminds us that a country churchyard may hold

> Some heart once pregnant with celestial fire;
> Hands, that the rod of empire might have sway'd.

The complications of the laws of heredity are enormous; the possible combinations of traits and the impossibility of accurate human records make predictions futile, but the chances of good progeny are best if humans breed according to the practices of animal and plant fanciers, avoiding bad and choosing good qualities. Which advice, like much we get from our economic advisors, will often prove futile.

# 8. Protective Devices

## REST AND PAIN

THE HUMAN BODY HAS MORE PROTECTIVE DEVICES THAN A modern football player. It needs them, for its ways are perilous, and despite the safety and first-aid manuals, and the art and science of medicine, and the voluminous medical writings of those minus medical degrees, in the final analysis the body has to take care of itself.

Care would seem to be the first great requisite for the safety of the body, but because of the part that chance plays in our lives and the infinitely greater value of things other than our own safety, the philosophy of "security" has never been given even the lip service that it gets now. The valetudinarian, one whose chief concern is his own invalidism, has always seemed an abject creature. We all may expect to be attacked by accident and disease.

### *The value of pain*

When we are thus assailed we may be fortunate to have watching over us an unattractive and much maligned guardian;

that is, pain. It has not been inflicted upon us because we have sinned, nor is it just a mean trick played upon us. Hard as it is sometimes for us to be thankful, nevertheless it has been given to us for our good. There are diseases, leprosy for instance, in which pain has been abolished and the patients do themselves serious injury without any warning. Cancer patients would have a much better chance if pain, at the beginning of their disease, would lead them to seek help.

So the physician should have an understanding of the significance of pain and a sympathy for the patient's feeling. When a doctor says, "Your pain is only muscular," it would suggest that the doctor has never had lumbago.

One trouble about underestimating a patient's pain is that the reaction may lead him to build it up beyond its real value. On the other hand the physician must remember that pain is usually an aid in diagnosis and abolishing it quickly may lead to dangerous error. Also, the patient, suddenly made comfortable, may refuse further proper treatment.

Some years ago I saw a young physician with the pain of appendicitis. When I said that we would operate right away he surprised me by remarking that he wasn't sure that he wanted it done. I told the doctor watching him to be sure not to relieve his pain. He took it for about an hour and then decided that he wanted the operation. The appendix was a red-hot one that undoubtedly would soon have become gangrenous. That man's severe pain was a blessing to him.

It is usually easy to handle acute pain either by deadening it with morphine or by getting rid of the cause with the proper procedure. Once an abscess is opened its severe pain is relieved. A broken bone in poor position is exceedingly painful. If there is not relief after the surgeon has set it, he should check carefully to make sure that it is really in good position. I believe that it is rare for a person to become a morphine fiend from the treatment of a single acute case.

With chronic cases it is different. People who become drug addicts have some weakness in their make-up; but chronic illness may be very weakening, even to character. Early in my career I had to take care of a miserable, whining specimen of a man who had been terribly sick over a long period. Several

years later an upstanding, two-fisted fellow introduced himself to me as the former patient. I should never have recognized him. Long recovered physically, he showed his true character.

Fortunately there have been developed, in modern times, several procedures to relieve chronic pain, aside from the giving of pain-controlling drugs. The removal of the Gasserian ganglion at the base of the brain has taken away the terrible pain from countless cases of tic douloureux, or neuralgia of the face. In certain kinds of hopeless suffering from cancer, surgeons cut part of the spinal cord for relief. Of late years they have been cutting the front part of the brain in order that the patient may not mind the pain.

In spite of all these developments it has been said that the greatest pain reliever of all is the humble drug aspirin. Few have tic douloureux. Millions have relieved their headaches, the pain of small accidents, and that of rheumatic fever and arthritis, with aspirin.

### *Rest, psychological and physical*

There have been few surgical classics. Mr. Hilton, of Guy's Hospital, London, England, wrote one about a century ago on *The Therapeutic Influence of Rest and the Diagnostic Value of Pain.* He pictured the expulsion from the Garden of Eden, the first wound, and resulting dismay; and, "the original promptings of nature to man for the alleviation of his altered condition. Pain was made the prime agent. Under injury, pain suggested the necessity of, and, indeed, compelled him to seek for, rest."

His thesis was that nature could heal the injuries caused by wounds or disease only when the affected part was allowed to rest. And by rest he did not necessarily mean lying in bed or sitting in a chair. He spoke of physiological rest. A piece of dirt lodges under the eyelid and soon there is a conjunctivitis. Nature cannot cure this as long as there is no rest for the tissues because of irritation. Remove the dirt and rest will soon effect a cure even without silver nitrate.

Compound fractures in recent years have been treated by good cleaning, and putting up the affected parts in plaster casts

where they cannot be disturbed by dressings or movements. This does not mean that the patient cannot tire himself out by traveling about on crutches. The patient with appendicitis gets physiological rest when the sick organ is taken out. Even a male can appreciate that a woman who was pregnant has achieved physiological rest when her constant companion of nine months is safely in the nursery.

On the other hand *sometimes physical rest is needed.* A physician caring for a rheumatic fever case may feel that he is putting extra work on the heart by allowing the patient to move about. He may doubt that this is compensated for by the aid to circulation that muscular activity gives. The liver is the largest organ of the body with a multitude of chores to do. Extra activity on the patient's part undoubtedly increases these chores. *So Dr. Chester Jones, of the Massachusetts General* Hospital, speaking to us a few years ago on liver diseases, stressed, next to diet, the importance of physical rest in treating these conditions. At about the same time Dr. Thorndike, of the same institution, depicted to us the dangers of staying quietly in bed. His patients were started walking within twenty-four hours of abdominal operations, women were up and about *forty-eight hours after childbirth,* and *even people with heart* trouble were let out of bed promptly.

How do we explain these apparently divergent views emanating from this shrine of Aesculapius? First we must remember the human propensity to swing upon a pendulum, and that in nearly all matters we go *in cycles from one extreme to another.* A short generation ago obstetrical patients spent several weeks of convalescence in bed, especially if they were well-to-do and could afford the care. The modern shortage of hospital beds and the general enthusiasm for acceleration programs have tended to demonstrate that this is not at all necessary. But analysis may show that the two methods are not so divergent in results when considered from Mr. Hilton's point of view.

Mr. Hilton had a patient who broke his leg and when put to bed developed jaundice. So Mr. Hilton reasoned as follows, "I believe the congested liver which leads to the jaundice results from the forced rest to which the liver is subjected by the recumbent position; the circulation through the organ up to

the period of the accident having been aided by active respiration and ordinary exercise. The withdrawal of these leads to congestion of the liver and hence jaundice." It may well be that when a patient is too inactive and the circulation slows down, actual physiological rest is thus lost.

We all believe in physiological rest. In each case we must decide whether complete bodily rest will give this. As Hippocrates said in his first aphorism, "Decision is difficult."

Although we will all accept rest as beneficent — and possibly my arguments may have produced a grumbling acceptance of pain — nevertheless it is with diffidence that I now ask you to include inflammation in this blessed category of protective devices. The word is, of course, closely related to inflammable, and refers to what Celsus, a hundred years after Christ, called the first of the four cardinal signs of inflammation: calor, rubor, tumor, and dolor (heat, redness, swelling, and pain).

## INFLAMMATION

Some years ago I was asked in public: Could a corpse on the beach sunburn? I answered this reader of who-dun-its by saying: Certainly not. Sunburning is a physiological process and such processes stop at death. In life the local blood vessels dilate, fluid pours out from them into the tissues; all the signs and symptoms of inflammation result: calor, rubor, tumor, and dolor. Only chemical reactions occur in the corpse.

Inflammation is the local reaction to irritation. The vessels dilate, bringing extra blood to the part, and hence we get the redness and heat and beginning of swelling. Much of the fluid of the blood passes out into the tissues, causing the major part of the swelling. Cells from the blood also work their way through the walls, the white blood cells or leucocytes being in the van. These actually eat up, as it were, the irritants. There are several kinds of leucocytes, the ones doing the bulk of the work in most acute infections being the polymorphonuclear leucocytes. They are so called because, instead of having one small nucleus in the cell, they have several of varying shapes. Medical men, as well as you, are bothered by these big words, so long before the modern alphabetical nomenclature became popular we referred to this leucocyte as p m.l.

If the inflammation occurs on a large scale, or is of a particularly serious nature, a hurry call for more leucocytes may be sent out. You might not expect an infection at almost any part of your body to have much effect on your thigh and other bones, but blood cells are formed in bone marrow.

Should you, following a nice dinner party, experience disturbing symptoms in your abdomen, you might proceed as suggested by the old advertising jingle:

> Said the lobster to Welsh rabbit,
> "Hurry up or we'll catch fits.
> We've got to get a move on.
> Here comes red raven splits."

But do not do this. Cathartics in some of the conditions that cause abdominal pain may result in bad ructions.

Your physician, finding pain and tenderness in the right side of your abdomen, may also be in a quandary as to whether he is dealing with an indiscretion in diet or acute appendicitis. He then does a white blood count. Ordinarily, there are about 8,000 white cells in a cubic centimeter of blood, 75 per cent of them being p.m.l.s. Should he find that you have 12,000 to 15,000, 90 per cent of them being p.m.l.s., you will probably be scheduled for an emergency appendectomy. The bones of your body are rushing shock troops to your aid.

There are many non-living irritants which can produce inflammation: electric and other rays, chemicals, bruises and wounds; but the living irritants would seem to be the most important and, of these, infectious bacteria lead. What I believe are the commonest, and on the whole are easiest to handle, are those which have a tendency to form pus. In a local infection caused by this type of bacteria the blood vessels become plugged with cells so that the circulation ceases and the tissues die. Then they break down and liquefy, and the p.m.l.s congregate in the liquid. The result is pus. As this increases, the pressure of the so-called abscess causes pain, which is relieved when the abscess is opened.

One of the best-known of these local inflammations is the common boil which is an abscess forming in a hair follicle or a grease gland of the skin. One of the commonest of bacteria, the staphylococcus aureus, causes boils and they are miserable

afflictions. They are exceedingly miserable for the tension is great, with resulting pain and tenderness, and the tissues do not liquefy quickly but a firm core persists. Hence cutting them open does not give the expected release of pus. Closely related to a boil, and even worse, is a carbuncle, in which the infection travels along just below the skin and comes to the surface at numerous points.

Although I started out this discussion of inflammation with the premise that it is beneficent it must be admitted that a detailed description of its working is not pleasant light reading. The details of battles are revolting to tender sensibilities but if our cause is just we approve of the efforts made in our behalf. The human body is continually being assailed by bitter enemies of which infections with bacteria are the worst. Inflammation, in its attempt to overcome these infections, causes us much suffering; but as we are dwelling on the battlefield it is sad but certain that we may never hope to remain comfortably at a distance while our champion strives for us.

## *The use of ACTH and cortisone in the treatment of inflammation*

Let us leave the field of battle and metaphor and speak of a new development which concerns inflammation. ACTH and cortisone, which from now on is used to include related substances, diminsh all the activities which grouped together constitute inflammation. Just as a bishop of London could say of the body social, "None make more trouble than those who go about doing good," so in the physical body, inflammation, intended for our good, can often do more harm than the condition which it is aiming to combat. This is strikingly so on the surface of the eye. The after-result of inflammation is, in perhaps most cases, the formation of scar tissue. Scar tissue on the front of the eyeball will not transmit light well. Therefore trouble here is excellently handled by cortisone. The remarkable effect of cortisone on arthritis is well known. Joint surfaces, like the eye, are too delicate to take well the strenuous action of inflammation. But cortisone does not cure, on the eye or in the joints.

However, it is well recognized now that it may be very unsafe to use cortisone or ACTH in some infections. Patients getting these drugs may feel comfortable and contented as they are not being disturbed by the aggravating activities of inflammation. But meanwhile the disease may be raging unchecked. Nature is unrelenting and we must be very careful how we interfere with her ways.

## IMMUNITY

### *Infection*

Pain, rest, and inflammation, then, are protective devices, guarding our bodies against injuries. It seems certain that the greatest injuries sustained are the results of infection. Our chief infections are from bacteria, animal parasites, and viruses.

Probably most of you think of bacteria as little "bugs" causing disease. You are mostly wrong. In the first place they are plants; and secondly, the different kinds of bacteria in the world are as the sands of the sea, and only a few kinds cause disease. The others have useful jobs and animal life could not exist without them.

Somewhere about the time of our Civil War, Louis Pasteur, a French chemist, showed that fermentation and putrefaction always were caused by living organisms. If I remember rightly, the first disease that he showed to be produced in this way was a blight attacking silk worms. Quickly after that, many diseases attacking human beings were shown to be due to bacteria, a particular kind producing each disease.

These latter bacteria are called pathogenic, which means disease producing and they attack only living tissue. They have been well advertised. Probably less well known to you are the saprophytic, which work only on dead organic matter, that is, plants and animals, and break it up. If it were not for them, the whole world would soon be buried in dead matter.

Innumerable are the good deeds done by bacteria. Collecting nitrogen is one of the chief of these. The animal body is largely protein, and the distinctive thing about protein is that it contains nitrogen. The supplies of nitrogen on the earth are

limited but the air is mostly nitrogen. Certain bacteria collect this air nitrogen for the plants and then it comes automatically to us.

Even in the body there are many bacteria that do us no harm but are actually necessary for our health. One of the bad

*A child being inoculated against hydrophobia in the laboratory of Louis Pasteur (1822–1895) A lithograph published in 1887. (Bettmann Archive)*

things about the modern antibiotic treatment is that not only the disease-producing bacteria are killed off but also the helpful ones suffer at times the same fate with bad results for us. One unfortunate fellow that I know was given penicillin and for some weeks was miserable with a sore throat and cough. After a heavy steel instrument was put through his mouth and throat and a piece cut out of a vocal cord, it was found that,

the normal bacteria having been killed off, the yeast took that opportunity to grow in abundance and irritate him.

So you see that you must be careful how you condemn and chastise whole groups, either of people or bacteria.

The disease-producing bacteria are not as the sea sands, but I think that almost everybody will agree that there are too many of them. It would be futile to try even to mention them all. My medical dictionary takes about four pages to list them. What I should say are the most common, or at least best-known, ones are the staphylococci and streptococci. The first are so called because they are found in clusters like bunches of grapes; and the second, in strings. As a working rule the first may be expected to form local lesions such as abscesses, and the second are more likely to spread rapidly. This distinction is not to be relied upon, however; any of them may run wild at times. If we see pus collecting about a fingernail we presume that it is due to staphylococci. If a surgeon pricks his finger with a needle while operating and a few hours later little or nothing is to be seen where the needle point went in, but red streaks are running up his arm and tender swellings are to be felt at his elbow or armpit, we fear that he has streptococci infection. The red streaks are due to infection and inflammation along the lymphatic vessels and the tender lumps are the lymph nodes attempting to stop the infection there. The first abscess may be opened and pus freed, with relief. Surgery will probably accomplish nothing in the latter case.

But all the infectious organisms have their own characteristic ways of attacking us. Typhoid goes at our intestines; pneumococci usually settle in the lungs; and diphtheria causes a membrane to form in the throat. All these villains cause acute conditions, but others, such as tuberculosis or syphilis, go slowly about their evil ways. We may not even know when they first attack us, but later, when fully established, they reveal themselves as difficult or even impossible to banish.

Nowadays these diseases are treated often with considerable efficiency; and many of the treaters talk much of curing them, for probably the most popular idea about overcoming infection in the human body is that the giving of some medicine will kill the infection. If there are potato bugs on your vines you sprinkle on Paris green and this kills the bugs. If there

is infection in the human body you give medicine and this kills the bacteria. There are many troubles about this latter procedure.

Medicines which are supposed to kill off bacteria often do not do too much good to the life of the body. Many diseases are insidious in onset and do much harm before we realize what we are fighting. There are many bacteria and they do not all respond to the same antibiotics. Even different strains of the same kind of bacteria are affected by different antibiotics. Now we are finding out that the bacteria are learning how to resist the antibiotics and we are not always so successful in killing them off as at first.

It is not at all certain that any of these wonder drugs kill off infection by hitting the bugs on the head, as it were. The forces of the body itself probably do the actual destruction. According to this theory, all that penicillin does to the streptococci is to make them more digestible so that the body devours them more successfully. The best chance for man to survive disease is to have an immunity. We are not so smart as we thought we were in licking disease after it has been established in our bodies.

### *Immunity*

Immunity means the being free from the effects of something and, as generally used in medicine, this is freedom from infection by disease. The methods, with which the body works to accomplish this, affect other situations, but here the discussion will be narrowed to the above.

There is no doubt that many aspects of immunity are not understood by scientists; one well-known authority, in fact, says that our understanding of these matters is but that of children. It is self-evident that the writer of the treatise which you are reading cannot assimilate all the large amount of knowledge that these scientists have accumulated. By a sort of law of diminishing returns what is handed over to and taken in by you is bound to be sketchy, but it is believed and hoped that what you see as in a glass darkly is merely indistinct and not distorted.

Undoubtedly all persons are born with some, but varying, degrees of immunity to different diseases. For thousands of years their ancestors had been fighting disease in the body and if they had not developed an immunity they would have ceased to exist. This is called an inherent, or natural, immunity.

Then they acquire immunity in various ways. First is that which the mother passes on through the placenta. Thus measles, diphtheria, and chicken pox do not affect infants in the first few months of life. Their bodies are not making this immunity; it has been loaned to them by their mothers, and after a bit it disappears. This is called passive immunity. Other special immunities the mothers do not seem to pass on. It is notorious that infants do not get immunity to whooping cough.

Immunity refers to the ability which an individual possesses or acquires to resist or overcome infection. The body functions in several ways to secure the individual against invading bacteria. The blood carries with it at all times substances and special cells which help to combat bacteria and their poisons (toxins). If certain toxin-producing bacteria gain a foothold somewhere in the body and secrete their poison into the tissues, these poisons are absorbed and disseminated, by the blood and lymph, to bring death and destruction to certain body tissue cells; however, just as soon as this course of events begins, many factors operate to combat the invasion. The white cells gather about the invading bacteria and engulf and destroy them; in addition certain cells in the body respond to the toxin-producing bacteria (antigen) by producing antibodies which act in several ways to defend the body.

One kind of antibody (opsonin) affects bacteria in such a way that they are more readily picked up and destroyed by the white cells of the blood; another kind (antitoxin) neutralizes the specific kind of poison produced by the bacteria quite as an acid is neutralized by a base. A third kind of antibody (agglutinin) immobilizes the bacteria cells and clumps them so that they are more readily removed by the white cells. These substances and other antibodies are produced only when a foreign protein substance, as occurs in viruses, bacteria, and their toxins, gains entrance to the body.

The details of the ensuing skirmish or possibly great battle

are complex. If the poison or bacteria win, the war is ended for that body. Fortunately most of us win innumerable skirmishes. These fighters which we enlist at short notice are so highly specialized that it will be necessary at this point to abandon the metaphor about a defending army. If a body is attacked by measles, the "antibodies," as we call the resisting force, are of no value against pneumonia. Each kind of antibody defends against only one disease. But what a job some of them do in their narrow special line! You all know that there are a number of diseases, one attack of which gives immunity for life.

The enormous amount of antibodies that may be poured out in response to the poison of an infection is demonstrated in diphtheria. This was a terrific scourge a generation or so ago. Diphtheria localized itself on mucous membranes, usually in the throat, where a membrane formed; but it also produced a highly poisonous substance known as diphtheria toxin which circulated through the body. The antitoxin to combat it was obtained by injecting toxin into a horse; first a very small amount which the horse could stand. This dose was slowly increased until in six months the horse could take one thousand times the amount of toxin which would have killed him in the beginning. Then the antitoxin obtained from him, when injected into a child, proved a successful protection.

Years ago, when typhoid was still common, a friend of mine had an attack. Recently she planned to travel in Europe and she consulted me. Would her previous attack of typhoid make her immune to it? It has been generally understood that people did not have second attacks of certain diseases such as typhoid, smallpox, and measles. These surely did give long-lasting immunity. But now it has been found that second attacks may occur as the immunity weakens with time.

I asked a health authority about my friend and he advised giving her a "booster" shot. Persons who have not had typhoid are protected against it by three injections of vaccine at weekly or longer intervals. This develops their immunity to a high point. A person who has had typhoid, or a series of injections not too long before, has a great deal of immunity but not complete. An occasional single dose will bring it up.

The apparent complete immunity in the old days resulting from an attack is thus explained. These diseases were always

Edward Jenner inoculating his son against smallpox. A statue by Monteverde.

lingering in the community. Most people were getting doses of the infection from time to time. If the doses were small and the recipients in good condition the disease was fought off and

each fight improved the defense. There is practically no typhoid around now and so my friend's defense might have weakened from disuse. But one good booster shot of vaccine presumably brought it right up.

**Vaccination.** I have mentioned that in the eighteenth century people deliberately caught smallpox from mild cases. It was a dangerous practice, for there was far from a certainty that a severe case would not result.

Then Edward Jenner, in the last years of the eighteenth century, investigated the belief, popular in the English countryside, that an attack of cowpox protected from smallpox. He took matter from the hand of a dairy maid with cowpox and inoculated a small boy. Two months later he took matter from a smallpox pustule and put it into the same boy, who did not get the disease, thus demonstrating his immunity. Innumerable observations have proven to all logical minds that vaccination is an almost certain preventative of smallpox.

In my youth on Cape Cod pock-marked faces were not uncommon. A good-looking girl in my high-school class went to Boston and there got smallpox. She was no longer good looking. But today there is not much smallpox around and vaccination is going out of fashion. The immunity will drop way down in the population and some day smallpox, which has been building up its strength, may sneak up on us. We will be smart if we do not give up the habit of being vaccinated against smallpox.

Today we are finding that the heathen, dwelling in far parts of the earth where there is little hygiene and many infections, are doing better than we fortunate ones as regards poliomyelitis. It is now believed that it may be a common infection. We who keep fairly free of infection do not develop much immunity to it. The heathen are not much bothered with it for they have all had enough attacks to produce an immunity; but when we get an attack, we may be seriously stricken. Our extreme susceptibility makes a polio vaccine a dangerous thing.

The difficulties with the Salk vaccine rather parallel what occurred with Jenner's smallpox vaccine about 1800. The best physicians were slow to accept vaccination until it had given evidence of its worth. It took some time for them to learn just


*The Cow Pock, or The Wonderful Effects of the New Inoculation.* An eighteenth-century cartoon by Gillray, published by the Anti-Vaccine Society, showing the popular fears and superstitions about Jenner's discovery.

how to handle it and there were a good many bad side results, such as septicemia and syphilis. Such great changes in medicine should be handled slowly and carefully. The first Salk vaccine caused deaths in California and Idaho because the government tests had not been perfected enough to make sure that there was no live virus in the first vaccine. This is no criticism of the ultimate worth of the vaccine but of the hurried way in which it was introduced.

**Immunity to poisons.** The whole story of immunity is infinitely more complex than my little kindergarten discussion may have suggested to you. At the present time virus infections are in the limelight. Immunity to poisons may also occur. Thus De Quincey, in his *Confessions of an Opium Eater,* says that at one time he was taking daily laudanum equal to three hundred and twenty grains of opium. One grain of opium is a good dose and it would not take many grains to kill the ordinary individual. Certainly he built up a tremendous immunity. He tells how at one time in the country he was visited by a Malay who spoke no English. For some reason, not quite intelligible to me, he gave the man some opium, enough to kill three dragoons and their horses; to his surprise and horror the man swallowed it all at once. He heard of the man suffering no ill effects and decided that, like most orientals of those days, the man was an habitual user of opium and had built up a strong immunity.

### *The protective devices work together*

Naturally these protective devices do not work independently but join in teamplay. It may well be that at times we cannot classify a certain activity under one definite heading. Inflammation is certainly a part of immunity. And no matter how efficient this is, there is bound to be damage done in many cases before it has things under control.

## REPAIR

To get the body, which has had inflammation or disease or injury of any kind, back to anything approaching normal, there

must be repair work done. This is as fundamental a process as is inflammation, and it occurs throughout the vegetable and animal kingdoms.

A tree can be badly injured and do a marvelous repair job to itself. I had a twenty-foot elm in my back yard. Boys sawed nearly three-quarters of the way through the trunk and the chances of the tree's growing up to be a fine specimen looked slim indeed. But on the edges of the cut, the live layer of bark started to grow and fill in. Gradually this filling-in closed around the trunk so that the sap was nowhere cut off from its upward course. Now, not many years later, the tree is in fine shape. The only evidence is a ring – a sort of scar tissue – that looks like swollen bark and that goes three-quarters of the way around the trunk.

In the kingdom of man and beast, the lower in the animal scale, the more complete is the regeneration. We are told that if a lobster loses his claw he grows a new one. Man cannot reproduce even a lost little finger. Cut off a lowly earthworm's head and he grows a new one. Only metaphorically can we do anything like that. Even in the human body this rule of the power of comeback of the lowly holds good. Our nerve cells are highly developed and specialized. Destroy one of them and it is gone forever and no other can take its place. Poliomyelitis destroys nerve cells in the spinal cord. That ends the activity of the muscle fibers which they controlled; hence the well-known paralysis. At the other extreme are our connective tissue cells. Their job is a simple one: just holding things together. They are usually rather small quiet things; not much to look at. But injure this tissue and the cells swell up and reach out towards one another like the line men of a football team bunching up to stop a line plunge.

Apparently the injured cells spill some substance which stimulates the remaining ones and a substance called collagen is formed. This is a Greek word meaning glue. In my youth I had access to a wood-working shop and I was told there that the broken rocker of a chair neatly fitted together and well glued would never break again at that spot. That indicates the value of collagen. To get enough of a good-quality collagen, one must have plenty of Vitamin C, which is found in fruit and

vegetables. So always have your glass of orange juice for breakfast and a nice crisp salad for dinner. Another hint: onions are rated a high source of Vitamin C, so

> Let onion atoms lurk within the bowl,
> And, scarce suspected, animate the whole.

It was said in the above paragraph that some substance from the injured tissues stimulates the cells to repair. Stimulation and irritation are the same except possibly for the question of degree and it is interesting that Dr. Alexis Carrel found that if an aseptic (that is, uninfected) wound was carefully cleaned of all blood clot and debris and completely protected from outside irritation, no healing would occur. I like the word heal meaning hale, healthy or sound, which is more personal than repair. Except when used figuratively, heal refers to living matter, while an old pair of shoes or anything inanimate may be repaired.

The ideal healing occurs in such wounds as a surgeon may make where the surfaces are brought together accurately and held there by stitches. We have a lovely phrase for what takes place then: healing by first intention. The connective tissue cells interlace and contract, forming scar tissue, and the smallest blood vessels bud out, increasing the blood supply. The wound may heal firmly in a few days, particularly in the face, where the blood supply is profuse. Because of all this extra blood supply, such wounds are red at first, but later the blood vessels close off with the resulting white scar with which you are all familiar. The skin cells slide over the edge of the wound, closing it off. No new hair or sweat glands appear here for they are complex tissues, high in the scale.

Not all wounds, of course, are simple cuts, allowing the surfaces to be brought together. Much tissue may be lost and no longer do we have first-intention healing. Such wounds are closed in by what we call "granulation tissue." Great numbers of little loops of blood vessels grow out on the surface of the wound slowly forming scar tissue, which as it contracts has a tendency to shrink the wound. Infection in a wound increases the amount of granulation tissue, making the "proud" flesh with which many of you are familiar. This will resist the penetration of infection into the deeper tissue. The skin slowly

creeps in from the edges of the wound but the final result is likely to be an unyielding scar with thin, poorly nourished skin over it.

The state of the body also influences healing so that poorly nourished people, especially those not getting enough protein, do not heal well. One of the bad aspects of cortisone is that it interferes with healing as it does with inflammation. Repair and inflammation are closely related.

*Protective devices are rarely comfortable. Ask the soldier* who has to wear a heavy helmet or the foundry worker with *metal-capped boots. So in the body, quiet and comfort means* one of two things. In the vast majority of cases there is health and well-being. But occasionally disease, like an unwatched child, is up to mischief when it is making no disturbance. Then we are fortunate if we have baby sitters such as pain and inflammation to detect the culprit and stop his wrong actions, with repair to clean up the mess.

# 9. Mind and Body

## EMOTIONS

The relationship of the emotions and the body must have existed as long as there have been well-developed brains. When a wild animal finds itself down wind from a man and gets the dreaded scent, it is the emotion of fear which starts its muscles in a wild rush away. A large part of our modern conception of progress, however, is the making of new names, and psychosomatic has appeared in the last half century (*psyche*, the mind; and *soma*, the body). It is generally thought of as the influence of the mind on the body, but it is also the effect of the body on the mind.

The problem of which comes first is at times as baffling as that of the hen and the egg. The theory of William James was that the sense organs of the body are stimulated by an object and the resulting feeling of bodily sensations is the emotion. But Dr. Walter Cannon reports that he and others practically separated the cortex of the brain from the body and the animals still exhibited normal emotions. I do not see that we have to worry as to which is the cart and which the horse. We certainly see many bodily demonstrations of the emotions.

## *Manifestations of emotions*

A patient walks into a doctor's office. He has had an accident followed by surgery which has overcome the crippling effect. Although the day is warm, his hands are cold and clammy. As a simple examination proceeds, sweat trickles down from his armpits. In this case the patient is well physically, but fear of returning to work on the machine that caused his accident was expressed as plainly by his sweat glands as though he had told it vocally.

No part of the body reveals emotions more plainly than skin, of which the sweat glands are part. The blushing of embarrassment is notorious, although it does not seem so common as the sweating reaction. Certain persons have the blush tendency, and those who wish to tease them may do so by getting their attention in company and then saying something slightly embarrassing. It is not necessary to agree with one investigator who says that blushing is a reaction to guilt and is associated with cold sores and a tendency to sunburn. In my salt-water days I had many most innocent sailing trips followed by cold sores and sunburn. Yet the writer appeased me somewhat by saying that the patient with these reactions is usually above the average in intelligence.

Of course emotions, like all our reactions and functions, are primarily for our benefit, even though it may be a bit difficult to determine how sweating from the armpits when nervous and blushing when embarrassed fit into this great scheme. The raising of blood pressure with excitement is easier to understand. Whether fear causes us to run away or anger starts us fighting, we use up energy at a faster rate, and higher blood pressure furnishes us a greater flow of blood, bringing in oxygen and taking away carbon dioxide and other waste materials at a commensurate speed. This is all very well, yet when the Reverend Stephen Hales showed how to measure blood pressure he may have helped out researchers, but he made a lot of needless worry, not only to hypochondriacs, but to nearly everyone who reads scare medical articles and has to be examined by doctors. I suppose it is a rare phlegmatic person who does not pump up a little higher pressure at these times.

ila despescure auient de la depesceur del os.
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e la puldre uermaille si cu deuant dit est metez sur la

[illegible]
en puldre metez en cele liquor. si longemt mouez en
semble e metez en un equant mestier sera eschaufez
le linsil oinguez. E quant les burblettes creuerunt

Medieval medicine. *Left:* a case of mumps. *Right:* an operation for removal of a cataract. *Left, below:* a bronchial patient inhales healing vapors. *Right below:* a case of measles.

**Phobias.** One of the worst aspects of the emotions is the building up of needless phobias. Few possessors of these have the philosophy of the following friends of mine. "Sir, most apprehension is needless pain," Samuel Johnson, LL.D. "Unfortunately the human mind is ingenious in creating its own miseries," Dr. Oliver Goldsmith. "The worst troubles I had were those that didn't happen," Disraeli.

Phobia means fear but now it has been narrowed down to unreasoning fear. In its original meaning it was a more necessary emotion than love or hate. All animals at times meet enemies more powerful or more clever than they. If we do not have an instinct for self-preservation we will not be around to experience the other emotions. There is an awful carnage going on among those who do not have enough phobias for autos. But the colored boy who is pictured as trembling because he sees a graveyard on the other side of the road, the abode of spooks, has a distressing and useless phobia.

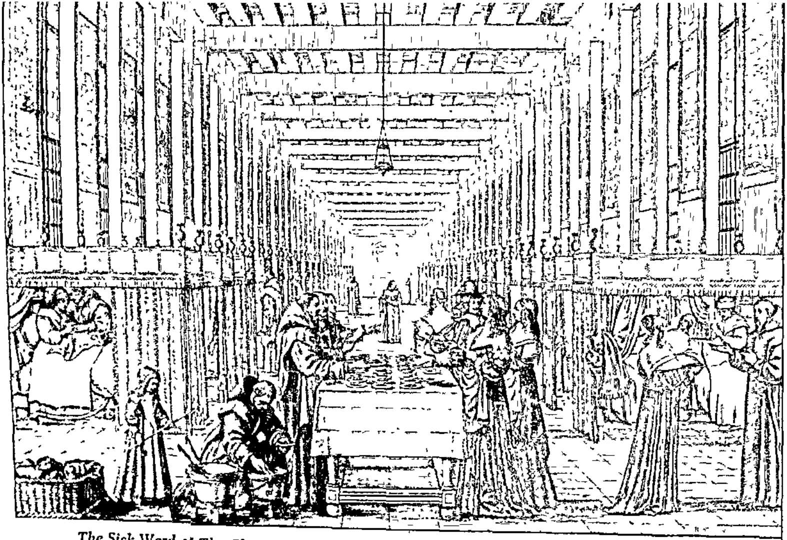
Psychologists now tell us that some of our phobias originate before we are born. You will have to discuss that matter with them. Childhood experiences must start a lot. I was middle aged before I had to give up my childhood home, but even then it required will power for me to turn my back on the dark inside of our barn and walk dignifiedly away. But I do not thing that a dark graveyard disturbs me. In fact I have slept quite a number of nights in a room overlooking one. It is often hard to distinguish between phobias and genuine fears. To my mind those who bundle up the minute the outside temperature drops below summer heat, put on rubbers every dewy morning, and shun drafts as I would the open door of a draft furnace, have phobias. Many people fear and dislike crowds. I, myself, do not like them. The public is a beast when there are too many people in one place. If one has to leave an enjoyable concert simply because there are too many other people in the room I should class that as a phobia. Clear thinking should allow one to weigh the value of fears. I knew that the feeling which I had in my dark barn was foolish and I never allowed it to influence me. If one has too much difficulty the proper physician should be called in, whether for a stomach ulcer or a phobia.

### *The psychic influences*

A re-examination of the last few paragraphs shows that they have been devoted to unpleasant emotions. A reasonable number of these are necessary for existence, but pleasant ones not only make life worth living, they help to preserve it. A quarter century ago I dropped into a surgical clinic and found that one surgeon used music in the operating room, not for the surgeons and nurses but for the patients. He also had an attractive woman whom he called his psychic anesthetist. She cheered up the patients or condoled with them. You can imagine that it took tact and good judgment to handle such a delicate matter. Later, in St. Louis, I found Dr. Vilray P. Blair using a special operating room for children. The walls and ceilings had colored pictures of fairies, Cinderella, Jack and the beanstalk, and possibly modern favorites. That was going a long way to use psychic influences on the youngsters.

Even longer ago there was a smallpox scare in the town where I went to college. It was decided to vaccinate the whole student body. The college physician, a tough, direct, former dashing athlete, not much given to babying his patients, realized that even such a simple thing as vaccination may be disturbing to the mind when the patient has to wait his turn in line. So he got a strikingly handsome, statuesque nurse to help him. Perhaps the boys then were not so engrossed in the other sex as they evidently are now, for several burly football players passed out before they got their scratches. Still, Dr. M. felt that the percentage was gratifyingly good. It is to be doubted that the stronger sex in the women's college needed this psychic reinforcement.

Devotees of music ascribe intellectual values to it, but I think they will acknowledge its chief effects to be emotional. Stimulation and excitement through its means, notably for patriotic and warlike purposes, have always been valuable and possibly could be used to tone up unhealthy minds. But many mental cases fluctuate from depression to extreme exaltation. It would probably be dangerous to stir them up. At the symphony recently, a modern, bizarre selection moved one of my fellow-practitioners with a lifelong interest in music to remark



*The Sick Ward of The Charity Hospital in Paris in the Seventeenth Century.* An engraving by Abraham Bosse. (*Metropolitan Museum of Art*)

that it made him sick. Emetics have occupied a large place in therapeutics, but I doubt if any one would advocate music for this same purpose.

At the State Hospital for Mental Diseases at Howard, Rhode Island, a quarter century ago, Dr. Arthur H. Harrington, a psychiatrist of high standing and long a lover of music, was superintendent. A thousand patients ate in the dining hall and it can be understood that disturbances at mealtime were not uncommon. Dr. Harrington started a drive which produced a ten-thousand-dollar pipe organ; he trained a choir of fifty patients who led the singing; and the music at meals was acknowledged to have such a wonderfully quieting effect that it became famous.

One more good word for the emotions. Dr. Paul Dudley White, who has devoted his life to the study of the heart, approves of the modern emphasis of the psyche over the soma — the effect of the mind on the heart. Nervousness increases the pulse rate. I have pointed out that just taking the blood pressure is likely to increase it. In the past much heart trouble was iatrogenic, a big and up-to-the-minute word that simply means that doctors caused it. The physician hears a heart murmur. He takes an electro-cardiogram and sees a change in the T wave, or some other alphabetical undulation. He then with a low voice and sympathetic manner tells the unfortunate of these matters and instructs him never to climb stairs again and suggests that from now on he must be a semi-invalid. A valetudinarian has been developed, a terrible word signifying a miserable condition. That sort of thing is getting less common. Nowadays we take a cheerful attitude and try to instill confidence, rather allowing the patient to do what he can comfortably, with some moderation. Nervous worry can be as bad as physical strain. The patient who has courage, optimism, and cheerfulness will do the best.

**Hysteria.** Hysteria, in medical parlance, is an exaggerated, unconscious control by the mind over the body. The word was evolved from the Greek for womb. This is a bizarre mental state with diversified symptoms and signs. In popular use it signifies uncontrollable excitement, or an unreasoning obsession, seizing groups of people. Thus the Salem witchcraft

episode in Colonial days was a mass hysteria. Medically we use the term for manifestations which superficially suggest physical abnormalities, but which when carefully studied are found to have no actual physical causes, but usually are evidence of a subconscious attempt to correct some situation that has become intolerable. Perhaps the simplest and best way to give you an understanding of it is to attempt no further definitions but to cite examples. Persons with perfectly good eyes or ears may find themselves blind or deaf. These are the kind who achieve miraculous cures by a parachute jump or faith cures. Others have areas of the body with no sensations of touch or pain. When these areas are plotted according to the patients' sensations they correspond not at all to nerve distributions. Thus with "glove" anesthesia, needles may be stuck into the flesh of the hand or wrist without disturbing the patient until a certain level of the forearm is reached. Then suddenly sensation occurs above this line although we are still needling areas supplied by the same ulnar and median nerves which did not function lower down.

Despite the fact that the name hysteria is derived from womb, this demonstration of the power of mind over body is probably equal in occurrence in the two sexes.

## *The effects of the emotions on the human system*

The word psychosomatic has come to stay, for the relationship between the bodily reactions and the emotions is well established. There are many diseases, the infections for instance, which will occur despite our mental attitude towards them. But there are some whose manifestations are distinctly physical which seem to be practically initiated by the emotions. The digestive system is especially prone to these troubles, as has been explained in the chapter on the digestive system. Throughout the body, nowhere is a lone hand being played, and the digestive system which is helping in the formation of blood, the storage of blood, and the handling of the sugar of the body (to mention a few of the jobs which it is doing on the side, as it were), is being helped or at times hindered by the emotions. Really, we should not talk of hindering

or helping. Both mind and body are working for teamplay, and if they get the signals mixed at times you must remember that their collection of plays would make our leading college teams look like a sandlot bunch of fifth graders.

Only in recent years has it really been appreciated how much emotions may disturb this system, although William Beaumont in the early nineteenth century watched their effect in the stomach of Alexis St. Martin. In recent years physiologists have noted that our nervous system and our emotions play almost a dominant part in the function of the stomach. A number of persons with permanent openings into their stomachs have now been studied, particularly one in New York who is a wonderful subject for this work. He is a fine fellow but strongly emotional, who likes, dislikes, fears, and worries with intensity. When he is disturbed, the lining of his stomach becomes swollen with blood, dark red; and the muscular action increases; and so does the secretion of digestive fluid. Under these conditions the stomach lining is easily injured, which may explain the incidence of ulcer. When the cave man felt this way he took a club and hit somebody over the head. He probably had no ulcer. We are paying one of the penalties of civilization with repressed emotions, which strike inwardly as it were.

It is not so easy to get hold of the emotions and treat them, so doctors have to treat the ulcers. Most of you have heard of the Sippy diet. Dr. Sippy has been a killjoy for vast numbers of people. The diet usually starts off with a dull visit to the hospital in order that the doctor may become acquainted with your mind and matter. You are given the most uninteresting of foods at frequent intervals. Then you have to take alkalies — things like cooking soda. You are also given sedatives to quiet your nerves and medicines like atropin which decrease your stomach secretions but also dry up your mouth in a disagreeable manner. This isn't much fun. The great majority of peptic ulcer cases get along fairly well. The best treatment is to cultivate equanimity and not develop an ulcer. Advice easy to give but hard for many to follow.

From here on down the alimentary canal the emotions have great influence. An acute diarrhea resulting from nervousness is not an unusual occurrence. Naturally there are at times some

sensations coming from the intestines, particularly when they are overloaded, or when peristalsis (that is, intestinal movements) is increased; or when there is much gas in the intestines. Incidentally, intestinal gas is now believed to be mostly swallowed air, and nervous persons are much given to increased swallowing.

Colitis, or inflammation of the large intestine, is a chronic disease sometimes going on to ulceration, when it is a distressful dangerous condition. It seems pretty certain now that it is definitely linked up with the nervous system and emotions. The nervous impulses increase the amount and activity of the digestive juices. They may then break through the protective mucus which the whole tract secretes. So we get ulcers in the stomach and duodenum, or colitis lower down. The patient has to go on a bland diet and be denied all sorts of pleasant things. This would seem to be a rather dull life but I know a woman who is a great and famous mountaineer, yet she gets along without coffee, alcohol, tobacco, and onions and appears healthy and, what is more, cheerful.

Medicine has undoubtedly concerned itself mostly with the physical side of man and has been chary of admitting the part that the emotions have played in physical ills. Only in recent times have psychology and psychiatry assumed large importance in medicine. Yet, emotions have much to do with regulating bodily functions. We are stressing this influence more in the handling of illness.

Such things as anger, grief, and other emotional upsets may be the foundation of bodily upsets. Joy, pleasure, and most particularly courage are great aids in treatment. At this moment there come to mind two persons whom I have recently referred to capable physicians. One appeared to be developing rheumatoid arthritis; the other was obese. In each case the emotional background was immediately studied.

**The placebo.** Practitioners have a great plenty of patients whose chief, if not only, troubles are emotional. Many medical men will tell you that such make up a large part of their patients. These are the ones who benefit much by our famous medicine, the placebo. One definition of this is an inactive medicine given merely to benefit a patient. Another is a

medicine given more to please than to benefit a patient, but a philosopher has remarked that anything that pleases does some good.

Of course many a drug is a placebo for the physician as much as for the patient. For years practically every sick eye in the so-called civilized world has been treated by a boric acid eye-wash. A small amount of boric acid, not taken internally, is an inert thing; but washing out the eye was good and everybody agreed that it was the proper thing to use. I have operated quite a bit in the mouth and I have a favorite mouth wash. A dry crusted mouth is pretty miserable and this wash kept the patient more comfortable than morphine. It killed the smell a good deal and perhaps took a bit of stinging away. However, rinsing the mouth with a weak salt solution would have done very well, but the patient would not have thought that much treatment. How much of my treatment was placebo? Digitalis is valuable in certain kinds of heart disease. There is no doubt of its efficiency and few drugs have ever been used more. But forty years or so ago a young physician, who has since made a great mark, went about purchasing samples of digitalis in the drugstores of the city where his medical school was. He found that a large proportion had been kept too long and was inert when tested on frogs who have no emotions connected with their heart action. Yet the teamwork of emotions between the physicians, who knew of the physiological effects of digitalis, and their confiding patients slowed up many a heart.

Sir William Osler said, "Faith in the gods or the saints cures one, faith in little pills another, hypnotic suggestion a third, faith in a plain common doctor a fourth." Your doctor often has to make some tries in attempting to get you well. He undoubtedly uses placebos some in doing this. Man enjoys taking medicine and it is to be presumed that is because he has so developed the emotion of hope.

In Greek mythology Pandora was the first woman. She antedated our Eve, and as men wrote the mythology, she also was the cause of all our troubles. In her husband's house was a jar, containing plagues: gout, rheumatism, and colic for the body; spite, envy, fear for the mind. Curiosity made her lift the lid and out flew these and all the other plagues, but she closed it

quickly enough to hold hope, an antidote which had been left with the poisons. It may well be that these simple medicines, tinctured with hope, have done more good than even our modern wonder drugs.

## DRUGS

Man is the only animal that likes to take medicine but he brings the average very high. Arguments about this fact are usually of the all or none type. Dr. Oliver Wendell Holmes is frequently credited with saying, "If the whole materia medica could be sunk to the bottom of the sea it would be all the better for mankind — and all the worse for the fishes." Dr. Holmes liked to give out smart sayings, but he was a clear thinker and an able physician and actually he carefully modified his statement. Before sinking the drugs he excluded opium and anesthetics and specifics: such things as quinine for malaria and mercury for syphilis and iodine for lack of thyroid secretion. Then he was willing to drop overboard most of the other things which could be useful but more often were harmful. At the present time he would not so dispose of antibiotics, although there is more and more evidence that as they are now they cause much trouble. Unfortunately a large proportion of the populace are not like Dr. Samuel Johnson, who said that he could be abstemious, but resemble him closely in their inability to be temperate.

One cardinal rule in taking drugs is that any, active enough to help out the body, are powerful enough to injure it. A poison is usually a comparatively large dose of a substance which in proper doses is helpful. Few things in nature have been more of a blessing to man than opium. Yet you all know that the normal person can be killed by it or ruined if he habituates himself to taking it in large doses. In some states cyanide gas is used to execute criminals. In small amounts cyanides are pleasing and harmless flavorings; almond, for instance.

A drug may have varying effects on different people. De Quincey said that opium stimulated him and I have seen that he was right. Barbiturates, which are delightfully quieting for most people, may at times cause a delirium, especially in the

elderly. This change may develop fairly quickly in one who over a period of years has taken them infrequently but always

Adriaen Brauwer, *Bitter Medicine.*

with soothing effect. We get fairly well acquainted with the idiosyncrasies of the drugs which we have lived with for some time, but we never can be perfectly sure of the idiosyncrasies of the patients on whom they are used. The allergic reactions

are examples of this. With the present-day enthusiasm for treatment and the extravagant publicity which every new drug and treatment gets as soon as it is announced, it is more and more necessary to counsel caution.

Fortunately some useful drugs cause, with large or long continued doses, such unpleasant symptoms that they have to be discontinued before they do serious harm. Digitalis, so valuable in certain heart conditions, irritates the stomach at times, causing nausea and vomiting, so that the patient cannot continue taking it any longer. Ipecac's value is dependent on the nausea and vomiting it produces and must have been used much in the days when puking and purging were standard procedures. Many of you have doubtless experienced an excessive flow of saliva when you were nauseated. This increase of fluid is what makes ipecac in small amounts valuable as a cough medicine. The fluid increase occurs in the lungs, diluting the sticky secretions there and making them easier to cough up. I have a physician friend who has long had the foolish habit of tasting medicines. He sat at his desk one day advising mothers and occasionally sampling a bottle of syrup of ipecac. Later as he drove across the city he noticed that he was taking deep yawns. At his first place of call he leaned over to listen to a baby's chest and suddenly all went black. You see, ipecac causes not only nausea, salivation, bronchial secretions, but also anemia of the brain. As many medicines are made up of a combination of drugs it ought to be evident to you that there are possibilities of many unpleasant effects when you dose yourselves.

Some minerals have been used as medicines for centuries past; examples are antimony, arsenic, iron, mercury, and sulphur. Nevertheless, until fairly recent times botany has been considered the mainstay of medical treatment. Practically every growing plant has furnished a drug to be used as powder, elixir, infusion, decoction, or what have you. In the beginning they have all been used in a hit-or-miss manner as some savage associated his recovery with whatever plant he had used just before; or some country housewife tried out various herbs. It has been the difficult task of the botanically trained physician to determine which have virtues outweighing the adverse effects.

The early history of many if not most of these plants is vague. We are told that belladonna, or atropin from deadly nightshade, got its name because the beautiful ladies of Rome used it to give themselves large pupils which enhanced their looks. It is still used to dilate the pupils but not for cosmetic reasons. Quinine, cinchona or Jesuits' bark, grew in the jungles of South America. The story is that the Indians told the Jesuits of its virtue in killing off malaria.

Until very recent times bodily ills were treated by such things as

> . . . Pinkroot, death on worms,
> Valerian, calmer of hysteric squirms,
> Jalap, that works not wisely but too well,
> Ten pounds of Bark and six of Calomel.

Or even worse, such animal matter was used as powdered toads, for the viler the medicine, the more efficacious it was often considered.

> Musk, assafoetida, the resinous gum
> Named for its odor—well, it does smell some.

Then came the era of organic chemistry, that is, of compounds with carbon in them. All living organisms contain carbon. Since coal was formed from what were living plants, coal tar is a cheap source from which I suppose millions of carbon compounds are made. A German bacteriologist named Ehrlich finally produced such a compound, named salvarsan, which was valuable in treating syphilis. This started the science of chemotherapy, which is the chemical production of drugs for treating bodily ills. Modern chemists, with more skill than jugglers and slight-of-hand men, now start to make a drug with definite qualifications. They can form most complicated compounds and rearrange the different elements in them with considerable foreknowledge of what the results will be. When they finally get something with the wished-for virtues and which apparently lacks other qualities of a dangerous nature, then a modern wonder drug has made its debut. Unfortunately the will to believe and human impatience cause many false entrances.

## *The wonder drugs*

Chemotherapy is a very broad term which may well include antibiotics, but in popular parlance the latter term is usually reserved for penicillin, erythromycin, and numerous others, obtained from molds, soil bacteria, and other lowly organisms.

There is no doubt that these deserve the title of wonder drugs. Nevertheless they should be handled with discretion: there are many who have found that the antibiotics are two-edged swords. Some people have a penicillin or other antibiotic allergy which can be a torture, harassing the body with a red itching rash or intestinal upset. But mankind, whether holding a medical degree or just shopping over the counter, persists in ignoring the fact that any agent, powerful and active enough to do good to the diseased body, can also do harm. The antibiotics have indeed proved themselves miracle drugs, but they are not universally efficient. They will not stop the common cold and the infections which we all get from time to time and call grippe, the flu, etc.

New brooms sweep clean and these new drugs are often more efficient at first than when the infectious bacteria have become used to them. For instance, so many persons have dosed themselves with penicillin to prevent gonorrhea that a "resistant strain" of gonorrhea has developed which will not respond well to penicillin. Then there are certain bacteria and mold-like organisms which habitually dwell in our bodies without doing harm, apparently because they are held in check by the tougher bacteria which cause our usual infections. When the antibiotics have killed off the toughs then the former Caspar Milquetoasts assert themselves and may do direful things to us while we have no way to check them.

The latest and exceedingly popular drugs are the hormones. Thyroid extract was used in the eighteen-nineties. Insulin came along just after the First World War. Since these two hormones have been observed over long periods of time, their virtues and vices are, we believe, well understood. We may almost sanctify them. As to the many other hormones which have been recognized and a number of which seem to have been produced in pure form, I think that I may characterize

them by an old New England expression: "All deacons are good, but there's odds in deacons."

One should be exceedingly careful in making definite statements about hormones. Cortisone was no sooner produced than it was modified. Hormones are powerful agents for good or evil. Our knowledge of them is increasing rapidly, which should, of course, make for good, but they are difficult to handle. Presumably they are going to be the drugs of the future.

## *Drugs and the physician*

Thus you see that drugs are inseparable from medicine. With only a few of them does the profession expect a cure. In the case of many diseases which have increased in importance, while the infections have taken a back seat, the most we claim to do is to help. We do not cure heart disease with digitalis, but by slowing and strengthening the beat we give the heart rest and help it to work more efficiently. There are many good drugs which are not used to influence disease directly. Such are the anesthetics, the pain killers, and those which quiet the nerves.

It is difficult for the individual physician to form correct judgments as to the value of drugs. Impressions are not reliable. Any "herb woman," such as Mrs. Todd in Sarah Orne Jewett's *Country of the Pointed Firs*, has great certainty as to the value of her simples and may be perfectly genuine in her beliefs. The greater number of human diseases are self-limited and a few happy coincidences after taking medicines are unduly convincing. Long series of cases, careful observations, and good recording are necessary before conclusions can be reached.

The conscientious physician may get great help from the Council on Pharmacy and Chemistry of the American Medical Association. Practically all members of this group are professors in leading medical schools. Conscienceless quacks and also well-meaning, over-enthusiastic physicians are forever reporting the virtues of new medicines. The Council investigates most of these. The quacks usually have mixtures of no virtue

but also of little harmful quality. It would be dangerous to poison their "clients." Honest men may be wrong, however, so the Council checks on them. There is a weekly report in the *Journal of the American Medical Association* and also a book of *New and Unofficial Remedies.*

The great mistake of the therapeutic nihilist who decries the use of nearly all drugs is that he ignores what has long been spoken of as the influence of mind over matter. What nearly every human being, whatever is wrong with him, believes is that the proper medicine, if it can be found, will help him out of his difficulties. So, when he goes to a doctor, he expects that doctor to make a try for the correct drug. There is no folderol in his mind about self-limited diseases and the healing power of nature. The doctor knows that, and he, himself, being human, has the same feeling. So he writes a prescription or two, which in these days involves no picayune financial transaction. The doctor is not so foolish as I may have made him seem. There is a school of thought that feels that all protective devices of the body are largely dominated by the mind. Long ago Dr. Walter B. Cannon, in his *Bodily Changes in Pain, Hunger, Fear, and Rage,* laid the foundation for this. The theory has been much elaborated since. Although the whole system takes part, the brain, pituitary, and adrenals seem to play the leading parts. The doctor, with his confident ordering of medicines, appeals to the patient's mind and sends him optimistically into battle.

An interesting commentary on all this has just come to me in a recent number of the *Journal of the American Medical Association.* Dr. Emil Novak, the eminent Johns Hopkins gynecologist, wrote an article suggesting that few women need a sex hormone for the symptoms of the menopause, and those who do should take them by mouth rather than by injection. A physician wrote in to the editor taking exception to Dr. Novak's ideas and outlining his own handling of such cases. This was most definitely psychotherapy with numerous visits for education and reassurance. He concluded: "Why not do all this without the injection? First of all, in the beginning, the patient would not return. The 'shot' gives a 'respectable' hook on which to hang the visit to the doctor and it is up to the physician to give the proper weight to the injection." The letter, only a small part of which I have

given you, suggested a conscientious, earnest physician, and I am sure that his patient was in good hands. But one cannot help feeling that psychotherapy could be used without such adjuncts.

This discussion has had to do with the using of drugs by physicians. What about the many millions of dollars worth purchased by the public on their own (and the cost added to the statistics on the high cost of medical care)? Naturally physicians do not approve. When their automobile engines act badly, they turn them over to mechanics, skilled in such matters. They argue that the human body is fully as valuable as an auto engine and its complicated mechanism more difficult to adjust. But I am afraid that they are not credited with pure disinterestedness. The president of a large university remarked to me a few years ago: "I see that now that the public can get without a prescription an antihistaminic to use against colds, the profession finds objections to its use." Antihistaminics have not fulfilled their promise, but I still feel that the president knows a lot about education. My own feeling is that as we approach the millennium and you stop dosing yourselves, you will then require mighty little doctoring.

## ALLERGY

Where, in this book, to put in a word on allergy has been a problem; but then, everything connected with allergy is a problem. It was formerly said that one who knew all about syphilis knew all about medicine, for syphilis appeared in a multitude of shapes. Now, somewhat reversing the form of such a statement, we may say that a specialist in allergy must first have a wide knowledge of all parts of medicine. This broad knowledge is a good start but hardly sufficient to solve the problems of allergy. The allergy specialists find that the information about it is still incomplete.

There is a relationship between immunity and allergy. In immunity a foreign substance called an antigen stimulates the formation inside us of an antibody to combat it. Allergy is usually considered to be an undesirable manifestation of the antigen-antibody reaction. When a foreign substance gains

entrance to the tissues, the cells in turn produce an antibody against it. Where there is allergy the antibody in some manner attaches to certain tissue cells and renders them sensitive to further contact with the inciting antigen. After an appropriate interval, if contact with the foreign substance again occurs, some irritating substances, the chief one being called histamine, are liberated. These are thought to be directly responsible for the allergic signs and symptoms.

The human afflictions which are described as allergic would not seem to be due to the emotions but there are evidently two schools of thought as to the degree of relationship.

I have a friend who specializes in allergy and who describes himself as way out on the left. He thinks that the emotions play a small part. A woman has lived in the city all her life and has hardly laid eyes on a field of grain. Yet a series of tests show that her severe allergy is due to buckwheat. Further investigation shows that her husband is a furrier and uses buckwheat flour in his work. An asthmatic boy is sent west to school as his physician has a hunch that family difficulties are mostly responsible. The scheme works beautifully and he is entirely free of his asthma. Later on he feels that he needs more room furnishings and among other things a feather pillow comes on. Immediately his asthma returns. With thorough investigation undoubtedly most cases of allergy can be shown to have a physical basis. But they certainly can be aggravated by the emotions, or helped by a proper frame of mind. Most patients who go to a distant allergy clinic with buoyant spirit receive temporary relief. Unfortunately a good many later backslide.

Anyway, whether allergy is a manifestation of the immunity reaction, or is associated with the emotions, or, as is presumably the case, is related to both of these, it seems safe to say that it is a condition of unusual or exaggerated specific susceptibility to a substance which is harmless in similar amounts for the majority of people. There is good evidence that it is a familial trait or, in ordinary language, that it runs in families. Likewise, it usually represents an ingrown constitutional defect, which means that you are just built that way. No matter how well you are doing at any one time, you may have recurrences of different clinical varieties. These may involve skin, bronchi,

nose, intestinal tract. It may show as arthritis and trouble in the connective tissue, or, in fact, in about any part of the body. However, it should be stated that a majority of allergic individuals, whose allergies have been properly handled, become completely symptom-free and live normal, happy lives.

The word allergy is fairly young but the signs and symptoms have been noted for centuries. Of course Hippocrates referred to it long before Christ. Four centuries ago a cardinal was said to have been forced to withdraw every year at the time the roses were in bloom. Thomas Willis is well known to us doctors for describing some little blood vessels at the base of the brain which occasionally force themselves on our attention by rupturing. About the time that Charles II was living his riotous life, and our austere ancestors were developing our eastern seaboard, Willis described asthma. Only in the last century has "hay fever" been recognized. The English in particular have continued to be hay-fever minded, while we in America are more disturbed by other plants.

The man who really told us something was Dr. Morrill Wyman, of Harvard Medical School, who eighty years or so ago wrote a book on *Autumnal Catarrh*. He was the one who put a finger on that wicked, wicked villain, ragweed. Somewhat before his time there was a pretty strong opinion that asthma was a nervous affliction. One man whom I cannot identify told of "an asthmatic little boy who would say to his father, 'Don't scold me or I will have the asthma,' and so he did: his fears were as correct as they were convenient." We all recognize now that both nervous and physical effects play a part.

There certainly is no routine way to dodge allergy, whether or not your equanimity and peace of mind are catered to. I have a fortunate friend who is fond of the mountains and at the proper time he takes his vacation in the White Mountains, where he is free from the pollen and happy. Such travel is worth while. It is a different story when home life is broken up to seek some distant location where bodily reactions will be no longer vile. There are pollens and molds practically everywhere. Often at first there is temporary improvement, but too often it is short lived. But always if a move is tried it should first be on a temporary basis. Do not burn your bridges behind you. Arrange it so that a return may be made to the scenes,

friends, and associates of a lifetime if permanent relief is not found in the new place. Perhaps your psyche will come to your aid with your final return to your familiar and formerly loved surroundings.

The identification, regulation, and treatment of a case of allergy is a time-consuming, difficult job. Here is a rough outline of the manner in which it is usually done.

1. An exhaustive survey is made of clues and possible causes.
2. A general physical examination is made to appraise the patient as a whole.
3. Such tests as are called for to verify or disprove the clues obtained are now performed.
4. The non-essential items to which the patient is allergic or sensitive are eliminated. Common examples of these are pets, egg, lobster, feathers.
5. Injections are given to immunize against those things which cannot be eliminated from the environment. Examples: pollens, molds, and dust.

Succesful management of allergic problems demands not only tests but the survey of the patient as a whole and the employment of previous experience of like cases. All possible approaches should be used. Patience on the part of the doctor and the patient is essential. Trial and error are often necessary and that takes time.

There is a tremendous amount of enthusiastic study of allergy going on at the present time. Several of my friends attend frequently what they call their Sneeze, Wheeze, and Itch Club. I should think that they would need a little of this jocosity to brighten up their work which to an onlooker would seem to be long and difficult, often baffling, and with many discouraging setbacks. Yet its rewards are great.

Few things not lethal that happen to the human body are more distressing than the manifestations of allergy. To restore to comfort a child covered with itching eczema, or an older person gasping and fighting day and night for barely enough air to keep alive, is indeed a rewarding experience. Diligent study by devoted physicians and the discovery of numerous new agents are bringing this about with increasing frequency.

## *The psyche supervises all bodily activities*

One may ask: Why put allergy under the heading mind and body? In true Yankee fashion it may be answered by other questions: Why not? Where else would one put it? There seems little evidence that it is infectious or traumatic; certainly it is not a new growth; not a degenerative disease, as it develops at all ages. Although certainly physical in its manifestations, psychic influences often show themselves in it.

But then indeed why have a special section on mind and body? One may speak anatomically of the different parts of the body, but physiologically we find them inseparable from other parts, and the psyche is forever supervising their activities. The psychosomatic has been stressed of late, and it would be ridiculous to discuss the multitudinous and mysterious workings of the human body except from this point of view.

We may easily see with our eyes how emotions change bodily appearances, and numerous philosophers have taken the stand that emotions are always the result of bodily changes. The action of drugs is decidedly material. Many may take place in the test tube as well as the living body. But the therapeutic nihilist argues that when they benefit the body, as they most certainly often do, the psychic effect is the predominant one, and innumerable examples attest this. We are continuously penetrating deeper into what, now, our philosophy wots not of.

# 10. Medical Philosophy

## CHANGES IN SIZE AND DESIGN

Shakespeare speaks of the seven ages of man, but from the medical point of view man has been considered in three periods: childhood, when we practice pediatrics on him; the grown-up stage, when we have no special term for our procedures; and old age, when we now say that he is a candidate for geriatrics. But as Sir Thomas Browne points out, and as we are told that the Chinese reckon, we are nine months old when we are born. In many respects these nine months are the most important portion of our life, for we are then being formed in a pattern which cannot change.

Shakespeare put his words into the mouth of Jaques who was having an especially gloomy day, for a short while before, he had said:

> And so, from hour to hour, we ripe and ripe,
> And then from hour to hour, we rot and rot.

I am sure you do not like being compared to a rotten apple or to a "lean and slipp'red pantaloon . . . (ending in) second childishness." At the worst, normal life resembles Sir James Paget's

*The Bridge of Life.* A Dutch engraving of the seventeenth century, doubtless inspired by Shakespeare's lines on the seven ages of man. *(Bettmann Archive)*

disease, where the bone is continually being broken down but at the same time is built up; only rarely is the balance seriously disturbed. Shakespeare knew the mind of man better than his physiology.

The best you can do for the child during the first nine months in the moist climate of the mother's womb is to take good care of this parent. If all goes well with her, the chance of a satisfactory child developing is as good as is anything desirable in this world.

There is no great transformation when the baby is born. It just seems so because of the spectacular aspects of birth. He still needs to receive oxygen and give up carbon dioxide, but he uses his own lungs instead of his mother's; he prepares his own food in his digestive tract from now on; and for the first time bacteria begin to grow in his intestine, which has previously been sterile. How difficult to distinguish our friends from our enemies! We view bacteria with fear, yet evidently these intestinal ones have rushed to our aid. Later in life we find that these beneficent inhabitants of our alimentary depths may be persecuted by the wonder drugs just as the wicked bacteria are. The balance of nature has to be maintained here as in the great outdoors.

The baby's skin has been secreting a fatty waxy material and continues to do so after birth. The kidneys have already been secreting urine. Of course the muscles, including the heart, have been working. Whether the baby has been thinking I will not pass upon, but up-to-the-minute psychologists have suggested that he has been. In fact, the birth of the baby merely modifies, in a continuous sequence, his bodily functions. One of the chief wonders of our incredible body is the unostentatious way in which it adapts its activities as needs arise.

In our second age of man, a combination of Shakespeare's infant, "mewling and puking," and his schoolboy with "the shining morning face," I would say that the emphasis is on growth rather than development, though, of course, there are changes other than mere increase in size. In my youth, for example, I had the pleasure of knowing a young woman who, presumably because of some change in her pituitary gland at the age of three, had ceased to grow in stature. Later she was a

beautifully proportioned and unusually keen-minded adult, whose only lack of development was in her size. Otherwise she had progressed as all normal children do. It is our bones that largely determine our size. Not until a little over a half century ago, when Roentgen discovered the X-ray, did we realize how the bones grow from centers of cartilage which we often cannot see at first, and that some of these centers have not finished their work even when the person has reached puberty. Adolescence, the period between puberty or sexual maturity and the time when the individual has achieved the wisdom to vote, does not mark but accompanies the final change in stature. But this period signifies little, for Goethe said that man is a perpetual adolescent. The years from birth to the voting booth are the formative ones, but we are pretty well equipped before we start these, as the primitive functions necessary to keep us alive have been laid down, with the sympathetic nervous system in command.

Yet we learn to assume some partial control over even these primitive functions. Breathing we can stop for a while, or hurry up. Our bowels and bladder we learn to take charge of. On the other hand, the infant is born with the instinct to milk nourishment from a nipple, using for this purpose muscles in the cheek which will later waste away with disuse. Once lost, this valuable function cannot be acquired again.

The use of most of the voluntary muscles becomes automatic, particularly the ones with which we acquire skills. As age advances, the acquiring of new muscular skills becomes more and more difficult. However, a few people with inherent dexterity seem to belie this rule. We cannot generalize accurately about adolescence either of the body or of the mind. We see boys who are giants on their school football teams or precocious intellectuals like Thomas Babington Macaulay, who, when a few years old, could recite Scott's *Marmion* and knew several languages. But a few exceptional cases prove little. The progress of the great majority of us can be charted in advance.

The age of full maturity has been, except in a few states, set by the Registry of Voters at twenty-one, and I see no reason for questioning their judgment as we consider it from a physiological point of view. For the next quarter century there are

not necessarily any striking changes. The most evident, naturally, are the external appearances. The skin and its appendages most certainly do give a good many indices of age. That presumably is the reason why middle-aged women use so much paint, powder, and lipstick. Why the teenagers with damask cheeks and soft fresh lips do not take advantage of their superior youthful charms is their secret. It is perfectly natural for the skin slowly to lose its elasticity with advancing years and to develop small, rough growths. Most of these are harmless and unimportant. The breasts, which are appendages of the skin, have a good deal of weight in relation to their size, and the constant pull of gravity usually starts them sagging early in life. The disinclination of modern young mothers to nurse their children is founded largely on a belief that nursing causes a loss of fullness in the breasts. As a matter of fact, those who have not nursed also find a decrease in fullness which can be measured.

Rare is the woman who does not acquire a middle-aged spread and rare the dashing young soldier who on the twentieth reunion of his organization can get into his old uniform. Few advance through the years without eating enthusiastically and exercising in a more restrained manner. Then the change of texture of the bodily tissues results in a rearrangement of fat accumulations. As middle age advances you will probably have to squeeze into your old clothes or have them hang on you in folds.

One thing you may be sure of. Between twenty and forty, or fifty, you are going to slow up a lot. Your muscular reactions will change their speed so that even you will notice the difference. Fast athletes become second raters, though to the uninitiated they look as good as ever. That fraction-of-a-second lag is the difference between the good man, which the player still is, and the marvel which he was and which the man who takes his place is now.

Times have changed. I do not know why today a man in his fifties or sixties is not necessarily as much an oldster as one of his age was two generations ago. I fondly hope that a good part of this change may be due to the knowledge—and perhaps a little to the wisdom—that my profession has developed and has insidiously instilled into the general population.

## OPTIMISM IN MEDICINE

There is nothing more remarkable, I believe, than the power of living organisms to grow, to renew themselves, and to heal. In the human body our innumerable devices for this do a good job, sometimes beyond all expectations founded upon experience. Certainly, our body is affected by wear and tear always, and by disease frequently. There is, of course, a foundation of pessimism here which we may never forget, it being solemnly and dolorously dinned into us. We acknowledge the inevitableness of these agents, so adverse to the individual, and their ultimate triumph over us; but, with rare exceptions, we seek the aid of medicine to help us as we go, and to postpone the finish.

Not only do you, our patients, expect this aid, but you usually ask for a preview—what we technically call a prognosis. From the point of view of earthly life, we know that the outcome is certain, but rates of progress and the elapse of time in relation to disease cannot be charted accurately. Optimism is not only helpful to the patient but it is a worth-while attitude for the physician. Charles Sedgwick Minot, professor at the Harvard Medical School some years ago, was quoted as making a remark somewhat as follows, "Never tell an old woman she is about to die as she may live to dance upon your grave."

Never underestimate the power of nature. Some years ago a child was brought to our clinic with what was evidently empyema. That is, one side of the chest was filled with pus, a condition which not infrequently follows pneumonia. (Or did before the advent of the wonder drugs.) A needle was introduced between the ribs and about a teaspoonful of pus was withdrawn, thus confirming the diagnosis. The family was told that the child must go into the hospital for operation and when they refused they were then told that the child would die were this not done. Unconvinced, the parents took the child away. A few months later the district nurse pointed out to the doctor a tough little urchin, knocking all the other youngsters about the lot. "That," she said, "is the child whose death you promised if he was not operated on." Now this family won a 1000 to 1 bet. The physician must however remember this off-chance.

One of the liveliest of Harvard alumni at the age of four was paralyzed from his toes to his neck, needing artificial respiration to keep him alive. Although his legs never recovered, he has led an unusually vigorous, valuable life.

The students of the heart are now among the most optimistic. In the past, children with heart murmurs were trained to live as chronic invalids. Now even when there is other and more definite proof that they have lesions of the heart valves they are allowed to lead normal lives, and many are known to have lived to old age. Doctors are now urged to take an optimistic attitude towards these heart cases.

In the old days we were told that college oarsmen were short lived because of the strain on their hearts. Today it is known that they are long lived. The famous Harvard crew on which Senator Leverett Saltonstall and Dr. Charles Lund rowed at Henley came back to their twenty-fifth reunion several years ago and every one of them climbed into the shell and rowed.

The hut boys at the Appalachian Mountain Club in the White Mountains carry up to the tops of mountains all supplies on their backs and it has been a matter of pride with them to take enormous loads. Well-meaning and officious people made an effort to stop this custom, claiming that the future health of the boys would be injured. The club made a careful investigation of the lives of former hut boys and interviewed many able doctors. They got no evidence that heavy use of a normal young heart causes future disease. Most doctors now agree that they are astonished at how well a majority of patients do, who have survived a coronary occlusion. It seems wise never to give a final opinion from the standpoint of their giving up work.

Even in such a terrible disease as cancer our pessimism is not always justified. A friend of mine operated on a patient with severe abdominal pain and found a cancer at the stage where surgery could not help. He merely sewed up the wound and for at least a year after the patient was free from pain and apparently doing well. Operations never dreamed of a few years ago are now being done routinely on the lungs, heart, and blood vessels. For long, we have said that we assume more responsibility in refusing operation than in doing one. We hardly have to argue that now.

## OPTIMISM IN MEDICINE

There is nothing more remarkable, I believe, than the power of living organisms to grow, to renew themselves, and to heal. In the human body our innumerable devices for this do a good job, sometimes beyond all expectations founded upon experience. Certainly, our body is affected by wear and tear always, and by disease frequently. There is, of course, a foundation of pessimism here which we may never forget, it being solemnly and dolorously dinned into us. We acknowledge the inevitableness of these agents, so adverse to the individual, and their ultimate triumph over us; but, with rare exceptions, we seek the aid of medicine to help us as we go, and to postpone the finish.

Not only do you, our patients, expect this aid, but you usually ask for a preview—what we technically call a prognosis. From the point of view of earthly life, we know that the outcome is certain, but rates of progress and the elapse of time in relation to disease cannot be charted accurately. Optimism is not only helpful to the patient but it is a worth-while attitude for the physician. Charles Sedgwick Minot, professor at the Harvard Medical School some years ago, was quoted as making a remark somewhat as follows, "Never tell an old woman she is about to die as she may live to dance upon your grave."

Never underestimate the power of nature. Some years ago a child was brought to our clinic with what was evidently empyema. That is, one side of the chest was filled with pus, a condition which not infrequently follows pneumonia. (Or did before the advent of the wonder drugs.) A needle was introduced between the ribs and about a teaspoonful of pus was withdrawn, thus confirming the diagnosis. The family was told that the child must go into the hospital for operation and when they refused they were then told that the child would die were this not done. Unconvinced, the parents took the child away. A few months later the district nurse pointed out to the doctor a tough little urchin, knocking all the other youngsters about the lot. "That," she said, "is the child whose death you promised if he was not operated on." Now this family won a 1000 to 1 bet. The physician must however remember this off-chance

Leukemia, a disease of the white corpuscles, is considered deadly and yet a few years ago a near neighbor of mine lived on for well over a quarter century after her diagnosis had been proved. Childhood diabetes was quickly fatal until insulin was discovered in the early nineteen-twenties. Some of the earliest children to get insulin are now nearly middle aged and still doing well. Some of us doctors, who have been attending our tumor clinic since its beginning, are greatly cheered when a patient whom I will call Mary makes her yearly visit. She is now an attractive woman of forty-two. When she first came to us as a lovely girl of seventeen an operation showed that she had a bad type of tumor at the back of the neck and close to the spine. Another operation and two radium treatments, followed by skin grafts, were necessary and then a growth in the chest appeared, which was treated by X-ray. Yet for a dozen years now Mary has been in good health with no symptoms of trouble.

And so it goes. New methods of hygiene, new drugs, new types of operation, and what I think fully as important, new knowledge of physiology, are accomplishing great things, as you can see from all the health statistics. Thus you have a concrete basis for being optimistic, and it is easier now to approach health problems in this way.

Yet even before all these new developments had come to our aid, the will to believe had been a strong factor in our favor. We are beginning to understand, although not too clearly, that the brain, working in conjunction with the pituitary and adrenal secretions and probably more indirectly with other bodily forces, has made cheerful determination a strong factor in combating our internal enemies as we have always believed it did in physical strife.

## GROWING OLD*

When is a man old? Van Wyck Brooks, in his *World of Washington Irving*, says of William Bartram, the eighteenth-century botanist, "Too frail to travel any longer, for he was in

* Many of the thoughts and some actual sentences in this section are taken from an address delivered by my friend Dr. Alexander M. Burgess, and published in the *Brown Alumni Monthly*, Summer Issue, 1951.—*Peter Pineo Chase*

Leonardo da Vinci, *Self-portrait.*
A good representation of serene old age.

his early sixties . . ." In the First World War I saw thousands of patients, all young men. One day in one of the hospital beds I found an elderly man. Later I learned that he was in his early forties, not very much older than I was. During my boyhood on Cape Cod I knew many retired sea captains, gray haired and gray bearded, who were in their fifties. I am sure that they agreed with me that they were elderly. We have had to revise our standards.

To what do we, who have survived longer, owe the success of our initial striving towards longevity? First and most important is the choosing of the proper progenitors. Some people are built to last—others are not—and we are all living within the limits set for us, which, by taking thought, we can no more exceed than we can add a cubit to our stature by the same process. So much for heredity; then comes environment. The improvement in living conditions, the development of better public health and hygiene, and the great advances in modern medicine and surgery have worked in our favor. And the third great factor is destiny, divine will, or whatever each of us wishes to call it: the fact that the other fellow's brakes held, or that we took the second plane, which did not crash—that, as the fatalist puts it, our numbers had not yet come up.

Remember that certain evidences of aging are to be expected. To some gray hair or a bald pate. To almost all a less keen memory for recent events, a tendency to puff a little on the second or third flight of stairs, visual difficulties, less accurate physical coordination—all to be more or less expected if they remain within moderate limits. Like Dr. Holmes' ancient vehicle on its hundredth birthday:

> There are traces of age in the one-hoss shay,
> A general flavor of mild decay
> But nothing local as one may say.

How shall such elders live in the years that are still ahead? Physical, mental, and emotional health will have to be taken into consideration, as we are dealing with whole individuals who cannot be taken apart. The cardinal rule for the old-timer regarding his habits of life is, "Make no abrupt changes." In fact if he is doing reasonably well on the plan of life to which

he has become accustomed, it is probably well for him to make no change at all. Only when there is evidence of a clear and present danger in what he is doing, as for example the man with progressively failing vision who still insists on driving his car, should we call a definite halt.

Even in the case of habits generally agreed to be harmful one must remember that more harm may result from a change in the plan of living than from the bad habit, despite which life has gone on pretty well. If one follows the motto, moderation in all things, one can often rest assured that the continuation of a bad habit, but in moderation, will be the best solution of the problem. If an eighty-odd gentleman says that a few cigars a day is his greatest comfort, let him have them even though he has a cancer of the lip. A ninety-year-old woman was under my care for a cancer of the uterus. When the family found that she was taking cold morning tubs in December they stopped her. I am vindictive enough to wish that I could have made things uncomfortable for the officious meddlers.

My friend climbed Mt. Washington on his eightieth birthday as he had done on every birthday for a half century. Oliver Hoxsie shoed horses until he was eighty and then quit because his wife was sick. He was dead in three months. Perhaps that was not cause and effect; perhaps it was. Consider the fat old man who cuts out his lifelong use of tobacco—and gets still fatter; or another fat one who cuts down so far on his diet that he becomes unhappy and depressed. All these and many such have happened, so beware.

What about exercise as a general proposition for the aging? It is a good thing if one can do it comfortably and without evidence of distress. What kind and how much varies with the taste and training of the individual. The man who is used to playing singles at tennis, and does so without apparent symptoms, had best keep it up. You may remember that the king of Sweden did it into his eighties. I imagine, though, that he did not try too hard for some of the distant shots. Although I have no statistics on which to base my opinion, my own guess is that the old man who keeps in training by a moderate amount of regular exercise is a better bet than his sedentary colleagues. The more we learn about the human body, the surer we are

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that it should be kept up and doing. If we do not use our muscles they suffer a loss of tone, we become less accurate in our use of these muscles, and our joints stiffen.

I have often been asked about the use of alcohol and tobacco. My friend, Dr. Alex M. Burgess, has a standard answer: "Tobacco may get you into trouble with your arteries; alcohol with the police." As for tobacco, it has a definite and demonstrably damaging effect on blood flow and is contra-indicated in some diseased conditions. But here we are not dealing with disease but rather with healthy oldish men, and to no one who has reached the age of sixty-five or better and is satisfied with life as he is living it would I advise a change in habit as regards smoking, beyond the general suggestion of moderation.

Alcohol presents a similar picture. Used with moderation and judgment as we may see many good citizens doing, it should not be the cause of trouble. That "a man is a fool if he drinks before he is fifty, and a fool if he does not after fifty" is, as far as the second part of the statement is concerned, probably complete hooey. Used in moderation, alcohol doubtless adds to the joy of life in many people without damage, and if we stick to our plan of "moderation" we probably will do well.

What about work; keeping going, staying on the job? Work that has been interesting, time consuming and a main occupation during life? Should we quit? Can we retire? There is a strong modern attitude that just this should be done; that old people serve no sociological function. Almost everybody not self-employed is automatically dropped according to rigid schedules. It seems to me all a part of the over-regimentation of our times. The presumption that all people age at the same rate is just as ridiculous as the idea that they have special diseases as they grow older, expressed in the word, geriatrics, the diseases of old age. Dr. Robert T. Monroe recently brought out a book on *Diseases In Old Age*. You will notice that he said "in," which shows care in phrasing his title, for he says, "There are no diseases of old age; there are only diseases in old people." Most of the diseases of those who have had many birthdays are chronic ones. It used to be said that half a dozen "chronics" payed a physician's expenses.

It was formerly thought that old people must be allowed to

vegetate, that they should give up their ordinary activities, be wrapped up warmly, and their diet restricted. Even Sir William Osler quoted advice to the aged that they should gradually reverse their menu in the manner in which they had increased it in infancy until at the last they should subsist on milk. Nowadays if an octogenarian relishes corn beef and cabbage and his digestion seems good, a wise physician will allow it on his bill of fare.

If any of you are beginning to feel that you are getting elderly you should be reassured some by an article which was called to my attention a few years ago. The author, personally known to me, had had the unusual opportunity to study more than seventy nonagenarians and centenarians. He found them, on the whole, little different from the average well-preserved person of seventy. You see, these people had managed to avoid any serious disease, as more and more of us now may, and under these circumstances their bodies had worn out slowly. One striking thing was that, unlike most of you, they had not experienced conditions of abundance and prosperity and continually shortening working hours. (Probably your motto is "A short life and a merry one.") Few of them had made any deliberate attempt to attain old age. They lived as other people did. Most of them were "passionate smokers and not given to refusing alcohol." They were not vegetarians. Many of them had been married more than once and had many descendants. Heredity was in their favor, there being usually instances of longevity in their families.

You should see from all this that it is perfectly proper for you to wish for a long life, but foolish and futile for you to persuade yourself that by your own efforts you may have any certainty of obtaining it. At best your bodies will experience what we doctors call atrophy, which is shrinking or wasting away of tissues. In old folks this occurs particularly in the skin, the fat under it, and the muscles. That is why you notice their wrinkles, sunken cheeks, and skinny limbs. The old folks are pot-bellied. This is because their intestines are bigger and the elasticity of the belly wall being less, everything is slumped downward and forward. The cartilages between the bones of the spine atrophy, so some of the height is lost. The bodily

activities may be normal in quality but their volume and rate are decreased. The functions are not regulated with the promptness and smoothness of early life.

Do not be discouraged by this picture. The changes come so gradually that they are not noticed. Each stage seems normal after it has developed. The old folks have been able to adapt themselves to the decrease of their strength and capabilities. "Life proceeds in the tempo of adagio" (slowly, leisurely, and gracefully) and with great calm. None of you is going to equal the age of Methuselah, whose record is not official anyway, but many will reach three score years and ten. So look ahead and be ready to retire to other work, other pursuits in which you are thoroughly interested and which will keep you busy.

And then eventually we all must die. And what is this death towards which each of us has been progressing since the day of birth? Of its ultimate meaning, as of the ultimate meaning and aim of life, I shall not attempt to speak, for here we are dealing with fundamentals of faith and religion—the bases on which man builds his courage to face both life and death. But as to the mere cessation of the life process in our bodies—we have to face the idea and the knowledge that this will occur at some future time, but as it becomes imminent, most of us are destined to be unconcerned. Sir William Osler, commenting on notes made at the bedsides of more than five hundred people who were dying, says that most of us "go out of life as we came into it, unknowing and unafraid." We should all take comfort from the words of William Hunter, the great eighteenth-century physician, "If I had strength to hold a pen I would write how easy and pleasant a thing it is to die."

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